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denied, that instead of gaining ground in the minds of geologists, the idea of one vast and *universal* Flood, with which we naturally commence our youthful studies, is becoming every day more faint; and those who were, at one time, its most ardent advocates, are now either *tacitly* receding from their opinions, or have openly stepped forward, and candidly read their recantation respecting it. We find, for example, a late able President of the Geological Society of London, in his opening address to that body, thus frankly expressing himself upon the subject, and alluding to a similar change of opinion which had already been expressed by one of his predecessors. "Some fourteen years ago," says he, "I advanced an opinion founded altogether on physical and geological considerations, that the entire earth had, at an unknown period, been covered by one general, but temporary Deluge. The opinion was not hastily formed: my reasoning rested on the facts which had then come before me. My acquaintance with physical and geological nature, is now extended: and that more extended acquaintance would be entirely wasted upon me, if the opinions which it will no longer allow me to retain, it did not also induce me to rectify. New data have flowed in, and with the frankness of one of my predecessors, I also now read my recantation*."

We find a still more recent instance of recantation of this alleged error, recorded by its learned author, in the *Bridgewater Treatise* on Geology. That able writer, had long been known as the powerful advocate of this much disputed fact; but we are now informed, that subsequent investigation of the evidences on which his convictions were founded, have satisfied him that his former opinions respecting it, were untenable; and he accordingly renounces them, in a note at p. 95 of his first Vol., which note contains almost the only allusion that is to be found in the whole of that beautiful and interesting Treatise, to this remarkable part of the Sacred History*.

So far from condemning these candid admissions of supposed error, I look upon them as in the highest degree praiseworthy; nor can there be the slightest doubt of their disinterested and honourable nature, when we consider that they voluntarily level with the ground, some theoretical structures which were once regarded with general delight and admiration. Nor could I, indeed, be justified in any such censure, as I shall, myself, have occasion, like so many other geological students, to recant, in the following Treatise, some opinions which I had adopted on the same independent grounds, but which a more mature study of facts has subsequently led me to abandon.

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* Address of February, 1834. See also the note at page 410 of this Treatise.

Such, then, is the present state of this interesting and important question, respecting an event of which the Word of God has given us so detailed, and apparently so unequivocal, a description. Nor is that question less important in a *moral*, than in a *geological* point of view. It has of late become but too common, to view this, and such other subjects of the early History of the World as prove somewhat refractory when examined by *scientific* tests, as merely allegorical or fabulous relations, having reference, it may be, to facts that really have occurred, but highly ornamented by successive *traditions*, in order to suit the tastes of an ignorant and superstitious people. On this subject it has been most aptly observed, by a very recent writer, that "there cannot be conceived a principle more pregnant with mischief to the simple reception of Scripture. It is a principle unhappily of growing influence. It is applied amongst us to the circumstantials of the Fall; to those of the Deluge; to various other portions of Holy Writ; and is brought forward even in disparagement of the Prophetic Visions of the Apocalypse. It is a crucible always standing prepared with that which chemists never could attain; *a universal solvent*, in which every substance from which the Biblical operator desires to be disencumbered, is instantly melted away*."

But of all the details of Scripture to which this dangerous and ensnaring principle has been applied, none have proved more refractory than those of the Book of Genesis descriptive of the Flood, which are, in many respects so minute, that it is easier to reject them entirely, than to mould them into such a form as may be suitable to the prevailing opinions of the geological world. It must, indeed, be allowed to be not a little extraordinary and startling, that after so many years of ardent scientific research, the physical proofs of the Deluge should still be considered so unsatisfactory and inconclusive, as to have at length occasioned their almost entire abandonment, even as it were *ex cathedrâ*, and in what ought to be regarded as the most influential, and authoritative geological work of our times.

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* *Considerations on Modern Theories of Geology*, (1837,) by the Rev. Thomas Gisborne, Prebendary of Durham.

Under these circumstances, it may appear as the height of indiscretion and presumption, in any individual to stand up as the advocate of a rejected doctrine, in the present advanced stage of geological inquiry, and in opposition to the published opinions of men so eminent, as are now arrayed against him. So far, however, from the evidences of *a General Deluge* having become more obscure, they have, within the last few years, assumed, to my own judgment, the character of *complete demonstration*, and that, too, by a mass of exclusively *physical* testimony, which is not confined to one source, and which is yet so simple, and, in some points, so *universal*, as to be within the ready comprehension and reach of almost every inquirer.

X

I cannot but entertain a hope, then, that to the general reader, who reposes with greater confidence on the Inspired (though sometimes *designedly* obscure) Word of God, than on the fitful theories of even the ablest men, the disclosure of conclusive *physical* evidence, both as to the *fact*, and to the *period* of the Deluge, may be deemed of very material importance at the present juncture. To more scientific readers, who may either yet halt between two opinions on this subject, or whose convictions may be as firmly fixed in opposition to the fact, as those of others are in favour of it, I would merely remark, that *if* a general (and, in that case, of course, *a preternatural*) Deluge really occurred, and *if* a great change can be shown to have actually taken place upon the earth, by an infinitely more powerful aqueous agency than is now to be found in nature, and this at a period exactly corresponding with the Mosaic chronology, there must be some most important deficiency in the prevailing geological calculations; nor can we wonder at the character of *obscurity* with which geological theories are so commonly charged, if an *item* so vast and influential has been altogether omitted in their construction.

That the line of proof which I now adduce is *new*, as bearing on this particular question, will not, I believe, be denied. It has been the subject of patient and attentive study during the last four years, previous to which period, the evidences in question were as completely veiled *from my perception*, as if they had no existence in nature, although many of them had for years been daily displayed *before my eyes*. I have spared no pains in personally tracing out these proofs, from point to point, not only in our own island, but also over various parts of the continent of Europe: and the simple and obvious nature of many of the facts, in those districts within my reach, has enabled me to extend with confidence the same line of reasoning to every other part of the earth, where phenomena precisely similar, are clearly described by travellers. "To elicit new and prominent facts," says a recent and highly talented writer, "is the lot of few; but all may investigate *truth*, and thus contribute more or less, towards the advancement of knowledge. Moreover, even the humblest contributors may rest assured, that they are imperceptibly raising a structure, which will, sooner or later, include the conspicuous labours of their more fortunate coadjutors; in which structure, their labours will, indeed, still appear conspicuous, though their importance will be diminished as the fabric is extended around them*."

Under this impression, and in the hope of thus conducing to ultimate good, I am induced to offer this contribution to the general stock of *facts*, on which alone, scientific knowledge can be solidly based. From the critic, I feel that I can look for but little indulgence, while deliberately entering on the field of controversy, in opposition to so numerous a host of powerful combatants. But humbly invoking the Divine blessing, without which all scientific efforts, however brilliant, are to man but "*a stumbling block*," to God "*foolishness*;" and confidently trusting in the simplicity and clearness of the facts which have at length been disclosed, I submit both these facts and the inferences which seem naturally to flow from them, to the candid and unbiassed judgment of the world; and as the Sacred *Word*

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[*] *Prout's Bridgewater Treatise*, p. 548.

of God can neither err, nor stand opposed to His *Works*, however blindly or imperfectly man may interpret them, I trust that the issue of this question may ultimately tend to a clearer preception of that *Truth*, which is, and ever will be *Truth*, in whatever light, or attitude man may chance to contemplate it.

RAMSGATE,
May 1837.

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GEOLOGY OF SCRIPTURE.

CHAPTER I.

Introductory remarks on the natural and traditional testimony hitherto adduced, with respect to the Deluge.—Summary view of the question at issue.

Before entering upon the performance of the task which a sense of duty, much more than any vain or selfish gratification, has imposed upon me, it may be deemed expedient, in order to enable the general reader to form some idea of the importance of the question at issue, that I should endeavour to give a short summary of what has hitherto been done, both in support, and in refutation, of the idea of a Universal Deluge, of which so full and distinct a narrative is given by Moses, in the book of Genesis; and that I should explain by what means the belief in this narrative, once so general, is gradually dwindling to a shadow in the minds of thousands, and has now, at length, openly assumed, in the scientific world, the more tangible form of positive and avowed dissent.

As it is my wish and intention to treat this question exclusively on the evidences afforded by *natural* *phenomena*, by which, alone, it ought to be scientifically scrutinized, like any other disputed convulsion to which the face of nature is said to have been violently exposed, it is not my purpose to dwell, in this place, on the very numerous and striking coincidences to be found in the traditions of nations the most remote and isolated, the most civilized, as well as the most savage, respecting some great aqueous catastrophe by which the world has every where been supposed to have been visited at a remote period. This most interesting, and, to my own mind, conclusive general testimony, in corroboration of the Mosaic statement, has already been ably handled by numerous writers; and to those who are desirous of investigating this branch of the subject, I cannot point out a more complete and satisfactory summary of it, than has lately appeared in Mr. Sharon Turner's second volume of the Sacred History of the World. Amongst other authors, Humboldt, to whom we are indebted for so many interesting facts respecting the new world, has given an account of various traditions of the general deluge, which he found amongst the nations on the Orinoko and elsewhere. He thus remarks upon them: "These ancient traditions of the human race, which we find dispersed over the surface of the globe, like the fragments of a vast shipwreck, are of the greatest interest in the philosophical study of our species; and present, among all nations, a resemblance that fills us with astonishment; there are so many different languages belonging to branches which appear to have no connexion with each other, which all transmit to us the same fact. The substance of the traditions respecting the destroyed races, and the *renovation* of nature, is, every where, almost the same, although each nation gives it a local colouring. On the great continents, as on the smallest islands of the Pacific, it is always on the highest and nearest mountains that the remains of the human race were saved. When we attentively examine the Mexican monuments" (consisting frequently of *pyramids*), " anterior to the discovery of America, and penetrate into the forests of the Orinoko, and become aware of the smallness of the European establishments, their solitude, and the state of the tribes which retain their independence, we cannot allow ourselves to attribute this agreement to the influence of missionaries*." So conclusive, indeed, has this circumstantial evidence of some great and immense catastrophe been considered, and in such complete accordance with the unequivocal statements of Scripture respecting the deluge, that it is only within a few years, that any serious doubt of the fact has been started; and still more recently, that such doubts have grown into confirmed and avowed disbelief. Nor can we wonder at the general confidence with which these independent corroborations of the Mosaic record were formerly regarded, when we remember, that to these were, at length, added, the powerful testimony of some of the ablest geologists, whose conviction was drawn, too, from a class of *natural* facts, with which the older writers on the subject were entirely unacquainted; and whose writings appeared, at the moment, to afford almost complete demonstration of the fact of a general deluge, though there arose, as might naturally be expected, on such a subject, a variety of debateable points, in treating of its details. By the united labours of geologists, a vast mass of evidence was collected, even from the most remote quarters, by which it appeared that in every part of the globe, distinct marks of violent aqueous action were apparent on the surface; and that that surface consisted, in general, of beds of sand, clay, or gravel, in that *stratified* arrangement which unquestionably bespeaks a deposition in and by *water.* It was also remarked with much force, that these superficial beds, (which obtained the name of *diluvium*), differed most essentially from any other appearances exhibited between the solid rocky strata of the earth; and that on the existing surface *alone,* was found that *mould* or *soil* which is so necessary for the nourishment of vegetable, and, consequently, of animal life. Hence it might be justly inferred, that no such aqueous action as had evidently deposited these universal beds of diluvium, had ever acted, during the more gradual deposition of the sedimentary rocks; and that if a general flood had been the cause of the diluvium, it was the only event of the kind to which the phenomena of the earth bore testimony, although the obvious marks of less violent aqueous action were almost universal throughout the whole series of the secondary rocks. This covering of diluvium was found, more or less deeply, to overspread the plains *of the whole world;* while in the valleys or hollow basins, where the supposed diluvial action might be expected to have deposited it to a great depth, there, accordingly, a corresponding result was observed. On a more minute scrutiny of the component parts of this diluvial covering, it was found to consist, besides sand and clay, of gravel, more or less water-worn; composed of specimens from almost every variety of the solid rocks, and frequently with masses of such size intermixed, or strewed over the surface, and at such remote distances from the nearest corresponding rocks, *in situ,* that nothing short of some vast force of waters could be judged capable of the necessary powers of transport.

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* Amongst the numerous and striking traditions of this event, and of the origin of things, found in America, Mackenzie tells us, that the Chippewyan Indians believe, " that the earth was originally *one vast ocean*, without any animals except *a mighty bird*, whose eyes were fire, and whose glances were lightning, and the clapping of whose wings was thunder. On his descent to the ocean, and on his approaching it, *the earth instantly rose up*, and remained on the surface of the waters." — *Mackenzie's Travels*, p. 116.

We are forcibly reminded, by this tradition, of the second verse of the book of Genesis: " And the Spirit of God moved upon the face of the waters."

From the undisturbed positions of these superficial beds of diluvium, it seemed evident that no subsequent event of the kind, thus supposed to have been the agent of their deposition, could, by possibility, have occurred: for had there been partial or local convulsions worthy of the name of deluges, each must have left its own distinct testimonies behind it, for our examination. Nor was there observed any material variety, in the general character of the diluvial beds; they were found, on examination, to be extremely similar at every degree of elevation, from that of but a few feet above the sea's level, up to a height of many thousand feet; for the most elevated plains, of the loftiest Alpine regions, both in the Old and in the New world, were found to be covered with similar beds of water-worn sand and gravel.

It could not be expected, however, that the opinions of philosophers should be unanimous, even on evidence which appeared to speak so plain a language; especially when a plain natural *cause* was yet wanting, to which the alleged aqueous action could be attributed. The Diluvialists were called upon to show, not only a probable *source* from whence the waters of the supposed flood had been drawn; but also the original places from whence such prodigious quantities of transported matter could have been displaced, extending, as they often did, to a depth of a hundred feet or more. To the first of these demands a reply was found to be extremely difficult, consistent with the existing laws of nature, which were constantly insisted upon. With regard to the second, the valleys by which the present surface of the dry land is so admirably drained, were at once pointed out, as the evident sources, from whence the diluvium had been drawn. It was shown with all the force of complete demonstration, that the structure of their sides, corresponding one with the other, as to their strata, indicated a time when such valleys did not exist; and that of the solid rocks of every kind, such as came within its powerful influence, had been *scooped out* into valleys by some vast aqueous agent, while seeking, by the common laws of fluids, a new and a lower level. These were therefore termed *valleys of denudation,* from the circumstance of the superior strata of rock having often been cut through, and the inferior beds having thus become exposed. Here, then, was found, in the cavities of such valleys, a highly probable source of such prodigious accumulations of broken and water-worn materials as were found so universally to overspread the surface of all dry lands; and further to strengthen this idea, it was found that there existed a very frequent correspondence between the rocks of a district, and the materials composing the diluvium of the neighbourhood. Thus, in the chalk valleys, and in the plains bordering on the downs, the flints peculiar to that formation were often found to prevail, in a broken, but not always water-worn condition; while in districts composed of the primary and other rocks, a greater or less degree of such correspondence was not unfrequently seen. This fact was also, however, sometimes completely reversed, and gravel from the youngest secondary strata was found to overspread districts where the primary rocks exclusively prevailed *in situ.* Thus in some parts of the county of Aberdeen, which is entirely primitive in its rocks, the flints of the chalk formation, frequently containing the fossil shells of that rock, are abundantly spread over the surface, in a smooth and water-worn condition*.

It may here be deemed proper to explain, for the information of the general reader, that after an enlarged survey of the various species of rocks which are found to constitute the mineral surface of the earth, to the depth of many thousands of feet, it is now an unquestioned fact that a certain order and succession exists, which, though rarely, if ever, complete, in all its parts, on any one spot, is never found to be actually *inverted.* This regular succession of *formations*, as they have been termed, has been divided by geologists into several distinct classes. For our present purpose, however, they may be reduced to only two: *viz.* those deepest seated, and consequently, *oldest* rocks, such as granite, gneiss, porphyry, &c. in which no fossil remains of animals or vegetables have been found, and which are therefore termed *primary*; and those stratified rocks termed *secondary*, which repose upon the first, and which are arranged one above the other, in great variety, affording to mankind those rich mineral stores of coal, lime, free-stone, &c. without which the whole constitution of society would have been very different from what it now is. These latter rocks are distinguished from the former class, by the immense variety of fossil remains which have been embedded in them; and it is by the examination and classification of these animal and vegetable bodies, as distinguishing one group of rocks from another, that the series of secondary formations has been now subdivided under many different denominations. It is, however, foreign to my present purpose to enter upon what has proved so fertile a field for discussion, as the periods, and modes of deposition, of this varied catalogue of rocks. My object is merely to recall attention to the fact, that of all these rocks, by far the greater proportion are admitted, on all hands, to have arisen from the depositions of sand or mud, *in water*; and that the regular *stratification* of any rock must be regarded as an admitted proof of such aqueous action: for it is by the movements of a fluid alone, that earthy bodies, and other extraneous particles are sifted and arranged in distinct order, according to the specific gravity of each particle, as it sinks by its own weight to the bottom. It is, therefore, certain that as almost all the secondary, and many even of the primary rocks, are distinctly stratified, *water* must have been the common medium in which they have been deposited. Whether this water was *salt* or *fresh*, frequently becomes a question of considerable difficulty and discussion. But it is admitted that by far the greater proportion of such deposits were of *marine* origin, as is plainly testified by the abundance of sea shells which are now found embedded in them; while some rocks are supposed, on similar grounds, to have been deposited in fresh water lakes, or in brackish estuaries, from the species and condition of their fossil remains.

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* I have gathered such flints in various parts of the eastern side of the county, especially near Peterhead. The chalk formation does not occur, *in situ*, nearer than Flamborough Head, in Yorkshire

Among the numerous theories of which geology has, of all the sciences, been the most productive, owing to the difficulties in which the subject is necessarily involved, almost all of them have taught that many of the different rocks have formed the habitable surfaces of former dry lands; and that during a succession of alternate elevations and submersions, arising from volcanic agency, during an unlimited lapse of ages, they have all in their turn been so replaced beneath the waters, as to receive upon their surfaces fresh deposits, which were in time to be converted into stone, and to become, in their turn, subject to similar elevations and submersions. If it was urged by an opponent, that we know of no such convulsions in existing nature as would raise a continent, or sink Great Britain in the sea, he was told that as the historic periods were as nothing, when compared to the age of the globe, we cannot expect to have experienced, in so short a period as but a few thousands of years, more than such slight specimens of volcanic phenomena as are sufficient to prove the soundness of the theory; but that if we could remain long enough on the earth, we should certainly experience a renewal of such awful changes, as the condition of the strata of the earth so clearly indicate. In addition to the theories of such repeated and violent cataclysms, we are now also told of a constant and progressive power of slow elevation, by which our dry lands are, even now, becoming more elevated above the waters; and that in this slow, and, to human view, almost insensible, manner, aided by occasional throes from earthquakes, deposits which were once under the waters, are now found to constitute the high summits of the loftiest mountains. It is to one or more of such supposed natural changes from sea to land, and from land to sea, in detached localities, that most geologists endeavour to account for the prevailing accounts of partial deluges, so general even among the savage tribes of the earth, who cannot be supposed to be influenced, as we may be, by the records of the earliest written history. But in thus supposing that the greater number of the geological formations may have successively formed the surface of former dry lands, the important fact seems to be forgotten, that the actual junctions of almost all the sedimentary strata of the earth's surface, bespeak so gradual, and often imperceptible, a *transition* from one species of rock to another, that scarcely any reasonable doubt can exist of the uninterrupted deposition of the whole series, however difficult it may be to account for the changes that occur, both in the character of the minerals themselves, and in that of the organic beings, which are found embedded in them.

Thus from the highest and most recent of the tertiary strata, down to primitive granite, on which the whole are based, we find no one spot in the section where we can pause and say, " this was evidently the former surface of a dry land ;" because the points of contact all denote, that the surface of the inferior bed was yet *soft* and *moist*, at the period when the sediments which now form the superior bed were loosely deposited upon it.

From this short digression, we may now return to the consideration of those universal beds of diluvium already mentioned, and which are seen to possess a character different from that of any other stratum, in the whole geological series, with the exception of a few occasional beds of conglomerate, formed of water-worn pebbles, in some of the sandstone formations. The difference between the two consists in this, that while these occasional beds of water-worn materials are strictly confined to their own position in the series, and do not extend over other rocks, the strata which have been termed *diluvial* have been spread, without distinction, over every rock which chanced to form the surface of the earth, at the period of their deposition.

It appeared, then, to those who supported the diluvial theory, that while the action of *water* was self-evident, in almost every part of the mineral surface of the earth, and to a depth of several thousand feet, the particular aqueous action indicated by the universal covering of diluvium, was different from any former action, inasmuch as the one seemed to bespeak the comparatively tranquil movements common to the ocean, or to lakes; while the other as plainly indicated a violent and *temporary* character, leaving behind it, even at the greatest elevations, distinct marks of its universality, as well as of its power. Nor could there be any reasonable doubt as to the recent date of this aqueous action, as compared with the chronology of the more solid formations: for as the comparative age of each rock must naturally be decided by its relative position in the series, it was clear that this uppermost covering was the most recent of all depositions, and, consequently, nearest to the historic periods.

Under all these evidences, so favourable, in themselves, to the idea of a deluge, it was reasonable that, in the minds of those who entertained the diluvial theory, they should be connected with the traditions existing in so many distant parts of the earth, commemorative of some great catastrophe, by which each country is said to have been destroyed by a flood, though every land had its own way of telling the wonderful story, and each considered that *it* alone had been the principal sufferer: and when, to all this, was added the unequivocal relation of the Sacred History, as to the destruction both of the ancient inhabitants of the earth, and of the dry lands on which they dwelt*, together with a specific moral *cause* assigned for the physical event, the line of evidence appeared complete.

But strong as the argument even thus appeared, it was yet to be supported by a still stronger host of witnesses, to whose evidence it now becomes necessary to advert; witnesses so important, as to throw all traditional testimony entirely into the shade. As, from the very nature of the destructive event, it could not but have proved universally fatal to animal life, it was natural for geologists to expect to find incontestible evidences of this effect also; and to discover the remains of the dead, in that state of derangement which so violent and powerful a catastrophe must naturally have occasioned. This was to be looked for, as a natural and consistent consequence, if the former face of nature had been made the varied scene of animal enjoyment, as the Sacred Narrative had already taught us to believe. It is true, that the absence of such witnesses would by no means have cancelled the evidences already adduced, as to the fact of a recent flood of waters; but having been informed, by the same high authority, of the previous creation of living beings, who were to increase and multiply *abundantly* upon the earth, the absence of animal remains from strata that had been termed diluvial, would have thrown a shade of uncertainty over this latter statement, and would have afforded a strong ground for attack from the despisers of such unscientific, and therefore inconclusive, information. But as if to show that nothing should, in the end, be found wanting, for the full establishment of the Mosaic record respecting the flood, the remains of the dead were soon brought to light, with an abundance and variety proportioned to the ardour of the search, which soon became so general for them; and the museums of every country were speedily and abundantly furnished with splendid specimens of the highest interest and value. I do not here speak of those fossil remains which were procured in such variety, from the regular secondary strata before alluded to, consisting of *fish*, of *reptiles*, of *plants*, of *shells*, and even of *insects*, with which some rocks more especially abound, but in which, with a few rare exceptions, the remains of quadrupeds had not been discovered. It has already been explained, that there was a marked difference between the character and extent of these strata, and that of the stratified beds of diluvium above described. Still more distinct were they found to be, in the variety and species of their fossil remains. While, with the rare exceptions just referred to, (which chiefly occur in the higher part of the series, as, for instance, in the beds of the basin of Paris, and the corresponding strata, as elsewhere seen), the remains of land animals had scarcely ever been found*, nor the smallest indication seen of any former convulsion of sufficient violence and extent to cause a general destruction of animal life; the evidence of violent and wide spread death, as seen in the Diluvial strata, were most remarkable, and bore the most conclusive testimony of the *cause* of such strata having occurred *but once* during the ages, however numerous, which had elapsed since the common laws of nature had been instituted. The condition in which these fossil remains were found, was naturally subjected to the strictest scrutiny; and numerous debates arose, on individual instances, as, from time to time, they were brought to light. Without dwelling too minutely on this branch of the Diluvial evidence, it may be sufficient, for the purpose of the present summary view, to state the fact, that the shattered remains of animals, *all in a nearly similar condition*, were discovered in every land, and *almost exclusively* in those superficial sand and gravel beds, which, in themselves, presented the clearest evidences of recent and universal Diluvial action. Instead of *entire skeletons*, and *connected bones*, being generally found, as would have been the more usual state of such fossil remains, had the animals died a natural death, and been tranquilly deposited in mud or sand, by the common currents of rivers, such entire or connected remains were scarcely ever found in the diluvium. The general character of its fossils, was, on the contrary, that of *fracture and derangement*, even to a remarkable degree. It has already been observed, that such beds of diluvium had been found to exist, more or less, in every country on the globe, and also at every degree of elevation above the sea's level. It was soon found that their fossiliferous character was not less general. By the ardour of individuals, both at home and abroad, specimens were procured from all parts, both of the Old and of the New world, as well as from the continent of New Holland. In North America, and especially in the

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* "Behold I will destroy them, *with the earth.*"—(*Gen.* vi. 13.) "And I will establish my covenant with you, neither shall all flesh be cut off any more by the waters of a flood; neither shall there be any more a flood, *to destroy the earth.*" — (*Gen.* ix. 11. See also the second epistle of Peter, iii. 6, 7, and 10.)

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* Besides the remains of a race allied to the opossum, which were found in the oolite at Stonesfield, in Oxfordshire, some most singular and unequivocal proofs of the earlier existence of quadrupeds have been brought to light, in the form of *tracks* or footmarks of several kinds, which occur between the strata of the red sandstone formation, in more than one locality. I shall take a subsequent opportunity of describing this new species of *fossil*, and of pointing out the inferences to which such phenomena seem to lead us, in judging of the rapidity with which these deposits must have been formed.

United States*, and on the frozen shores of the Arctic Ocean, the detached remains of the mastodon, the mammoth, the elk, the rhinoceros, &c. were abundantly found in certain localities, which seemed to indicate such drifting together in the eddies of violent currents, as is observed, on a small scale, in the wreck occasioned by a flooded inland stream. The vast size of some of these remains, especially of the elephant tribes, (such as the mastodon and mammoth), naturally attracted the earliest attention; and these were also more frequently preserved, from the wonder which they excited, even in the ignorant peasants who discovered them. In South America, where the search has not been so keenly prosecuted, or where the wants of man have not yet led to such extensive operations, the fossil discoveries have been less numerous. But to other species, there have been added, from that country, the remains of the gigantic megatherium, which have, as yet, been found near Buenos Ayres alone. From Africa little has been discovered of this nature, owing to the difficulties experienced by travellers in attempting to penetrate to its burning deserts. But as the surface of that continent, as far as it is yet known, presents no exception to the forms and mineral character of other lands, we may reason from analogy, on its diluvial strata being similar in their fossils, to those of India, of Europe, and of the New World. From India have been lately brought the rich fossil rewards of a new-born scientific ardour, which has there sprung up within a few years, and which promises the happiest results to Science. Both in the eastern and western hemisphere, diluvial beds, and *fossils of the same mixed species*, have been found, not only on the plains, near the level of the sea, but also on the most elevated levels of their Alpine regions. In the Andes, at many thousand feet above the ocean, the fossil bones of *elephants* have been found; and in situations so surrounded by precipitous rocks, as altogether to preclude the idea of the living animal having ever existed there. Facts precisely similar have now come to light in India; and fossils have been procured from the neighbourhood of the frozen glaciers of the Himalayas*. It would be an endless task to enumerate the instances of fossil deposits, discovered in Russia, in Germany, in France, in Italy, and in many parts of our own island. In almost all of these, the condition of the bones, as well as the variety of the species which they represent, was found to be, more or less, similar. *Entire* skeletons were of rare occurrence; and the detached, and often broken, condition of the bones, was precisely that which we should expect among the *débris* of a flood of a year or upwards in duration. Had such a convulsion been *sudden* and *transient*, as in the case of a hurricane, or other common tempest, although the animals might have been destroyed, and even transported by water to a distance, yet their bodies would generally have been *entire*, and in this state also we should have often found their fossil remains. But in the case of a flood of upwards of twelve months' duration, wherein the bodies of the dead, becoming inflated by corruption, would be tossed to and fro by the winds and currents of the ocean, until these unwieldy bladders burst, and the mangled carcasses fell to

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* "The fossil remains of about thirty animals, now supposed to be extinct, have been found at the Big-bone Lick; and Mr. Bullock conjectures that there are more remaining. That these animals did not perish *on the spot*, but were carried and deposited by the mighty torrent, which, it is evident, once spread over this country, is probable, from the circumstance of *marine shells*, plants, and fossil substances, having been found not only mixed with the bones, but adhering to them, and tightly wedged in the cavities of the skull. 'Those holes where eyes did once inhabit,' were often stopped up by shells or pieces of coral, forcibly crammed into them."—*Six Months in North America*, by G. Vigne, Esq.

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* "Although elephants are too unwieldly to climb the mountains in a wild state, and have never been seen, even

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on the lowest ridge of hills that bound the plain, yet I am assured that their fossil bones are found in the highest elevations that man has attained in Thibet.

"Interesting discoveries of bones of enormous quadrupeds are now in progress in the mountain provinces on the north-west of Kemaon, under the indefatigable zeal of my friend Dr. Falconer, and Captain Cautley." — *M^c Clelland's Geology of Kemaon.*

pieces of themselves, this mixed and imperfect condition of the fossil remains appears to be a testimony of the most natural and consistent description. Cuvier has justly remarked, that " the associated remains of the *glutton* and the *hyæna*, the *rhinoceros* and the *rein-deer*, found in *the same caverns*, as we observe at Gaylenreuth and Brengues; the *bison* and the *elephant*, in the *same diluvium*, as we find in the valley of the Arno, certainly reveal either a state of the earth very different from what we now witness, or imply in these animals a temperament opposite to what their kindred species now display*." No such supposition is required, however, if we attribute the deposition of such remains, not to the common laws of existing nature, by which the carcass of an animal carried down by a river would now be deposited at no great distance from where it had lived, but to the only cause which could possibly have thus placed in juxta-position the remains of animals belonging to such opposite climates as the same species now inhabit. These mixed deposits, then, were found in every clime, at every degree of elevation, and always embedded in, or in conjunction with, such gravel and sand deposits as exhibited unquestionable marks of aqueous agency, and such as had become known to all geologists by the appropriate term of *diluvium*. In this gravelly or sandy matrix, bones were found at every depth, from that of a few feet to a hundred or upwards. From the larger and more apparent bones of the elephant, the rhinoceros, the megatherium, the elk, the buffalo, the stag, &c. Naturalists were led, by the elaborate studies of Cuvier and other comparative anatomists, to the remains of the antediluvian lion, the tiger, the bear, the wolf, the hyæna, the rabbit, &c. and, finally, to the more minute remains even of the water-rat and the mouse, all of which, with others in great variety, were at length arranged in order, on the shelves of our museums, and frequently in almost as high a state of preservation as those of the most recent specimens. In some cases, so complete was the confusion, and so obvious the action of *water*, in these fossil burying places, that the bones of many *different* elephants, were brought into close contact; and on some, oyster shells were fixed, thus denoting a former immersion in the sea, though they had subsequently been embedded in strata now far above its level. Thus, in the museum of Stutgard, may be seen a mass of diluvial clay, from Canstatt, in the immediate neighbourhood, of the dimensions of only about five feet square, in which, however, are seen the tusks of not less than *thirteen different elephants*, of great variety of size, and, as it were, matted together, along with other fossil remains! In like manner, in the extensive steppes of Siberia, and in the frozen regions to the north of Asia, such remains of tropical animals are found in the greatest abundance; and, as if to prove the truth of what has been stated, as to the falling to pieces of carcasses, after a long immersion, unless preserved from corruption by some ante-septic cause, almost the only known instances of fossil quadrupeds, in a connected state, have occurred in *the ice* of the Arctic Regions, where, in some remarkable instances, even the skin, the flesh, and the blood, have been sealed up and preserved for ages, in the exact condition in which the bodies chanced to be, at the moment of their being stranded on the shoals of the yet receding Diluvial waters*. Allusion is here made to the instances mentioned by Pallas, which occasionally occur in Siberia, where there is perpetual ice within a foot or two of the surface of the ground, in what would elsewhere be water, oozing through sand or gravel. "The bones of elephants," says an able geologist, "are found occasionally *crowded in heaps*, along the shores of the icy sea, from Archangel to Behring's Straits, forming *whole islands composed of bones and mud*, at the mouth of the Lena, and encased in icebergs, from which they are melted out by the solar heat of their short summer, along the coast of Tungusia, in sufficient numbers to form an important article of commerce*." "There is not," says Pallas, "in all Asiatic Russia, from the Don to the extremity of the promontory of Tchutchis, a stream or river, in the banks of which" (in diluvial matter), "they do not find the remains of elephants and other animals, now strangers to that climate. These are washed out by the violent floods arising from the thaw of the snow, and have attracted universally the attention of the natives, who annually collect the tusks to sell as ivory†." Respecting these islands near the mouth of the Lena, Cuvier states, on the authority of Belling, that one of them is *thirty-six leagues* in length, or one hundred and eight miles. This whole island, with the exception of a few little rocky mountains, is composed of a mixture of *sand and ice*. When a thaw takes place, the bones of the elephants, buffaloes, rhinoceroses, &c. are found in prodigious abundance. Belling, indeed, states, on the authority of an eye-witness, that almost the whole island is composed of the bones of these fossil animals. In a second island, about five leagues further, similar bones are found; but in a third, about twenty-five leagues to the north, there are none to be seen. Nothing can more plainly bespeak the effects of eddies in diluvial currents, than such *partial heaps* of animal remains. Had the animals *inhabited* these islands, or even the neighbouring continent, and their detached remains been deposited in a long course of ages, by the common action of land floods from the Lena, we must have found such remains more equally distributed over these islands. This idea has now, however, in some degree, lost its ground. Dr. Buckland, who formerly conceived that they were inhabitants of these inclement regions, on the strength of the coat of hair in which one specimen was found to be clothed, subsequently says: "Too much stress has, I think, been laid on the circumstance of the mammoth of the Lena being covered with hair* ;" and he instances the *hyæna villosa*, the lion, with a close and shaggy mane, the camel, &c. to show that a warm covering is not inconsistent even with a tropical climate. Pallas thought "that the Siberian fossils belonged to carcasses *drifted north*, from the southern regions, *by some violent aqueous catastrophe*." In the case of the celebrated elephant or mammoth found, in an entire state, near the mouth of the river Lena, and which is now in the Museum of St. Petersburgh, a coat of rough hair, with which its skin was covered, gave rise, in the mind of Cuvier and others, to the idea of its having been a *native* of these inhospitable regions, although they admitted that the food necessary for such an animal, or for the innumerable multitudes of them, which have been there interred, could not easily be accounted for.

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* *Ossemens Fossiles*; Vol. IV., p. 487.

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* Ludolfus, in the Appendix to his Russian Grammar, calls the fossil remains *Mammo-tovoikost*, and says that the Russians consider them as belonging to a species of animal still living, like the mole, under-ground. We can scarcely be surprised at this idea, since the *flesh and blood* of animals are thus occasionally found preserved, hermetically sealed up in ice, as insects are in amber.

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* *Reliqu. Diluv.*, p. 46.

† *Ibid.* p. 183.

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* *Appendix to Captain Beechey's Narrative.*

Much light has since been thrown upon this subject, by the fact, long overlooked, that even the present race of Asiatic elephants, instead of being perfectly *bare* as is so commonly supposed, have all, more or less, a coat of hair, though, in a domesticated state, in the East, this thin and incipient covering is generally removed, except on the head and in the tail, where it is carefully preserved. Bishop Heber saw a native prince mounted on an elephant, which he describes as "nearly as shaggy as a poodle*;" and we can therefore more readily suppose some climates to have formerly existed, sufficiently *cool* to develop a full natural coat upon some specimens of the elephant race, and yet sufficiently *tropical* to produce the luxuriant vegetation, without which such animals could not be supported, especially in such vast numbers as to be now abundantly scattered as *fossils* over every quarter of the globe.

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* Much doubt has been expressed with regard to the correctness of Bishop Heber in speaking of the above elephant. Conceiving it an object of considerable importance, in a geological point of view, and with reference, more especially to the history of the fossils of the Arctic Regions, I have had some correspondence with several able naturalists, well acquainted with India and its race of wild elephants, by which it seems certain that *all* elephants, when wild, have a coat of hair, more or less fully developed, according to the climate which they inhabit. From Mr. Boulderston, who was the temporary companion of the Bishop, while travelling through his district, and who also saw the rough-coated elephant in question, I have received a very full account of it, and also much valuable information on the race in general. He says, "my recollection of the little elephant, described by Bishop Heber, is, *that it was the most hairy animal of the kind I had ever seen.* I have frequently seen elephants of this kind, in various parts of India; and in a string of these animals, some, generally females, are of a lighter colour than the rest, and more hairy. This *variety*, when young, and *fresh caught, has very long hair*, in comparison with the black elephant; *but all elephants, when fresh caught, have a coat of hair*, which is generally broken off and

As in those Northern Regions, the numbers of such gigantic victims are well calculated to excite our astonishment and awe, so even in our own island, the seeming effects of diluvial *eddies* are not unfrequently seen; nor are such collections of animal remains less striking, as proofs of a recent deluge. Thus in the diluvium reposing on the chalk around Brighton, numbers of elephants' teeth and bones have been found; and on the coast of Norfolk, so immense are the accumulations, that in one instance within my own knowledge, near Hasborough, upwards of two hundred elephants' teeth, besides

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destroyed as they come into use, by their being rubbed by the mohauts, with the *jhama* (a piece of vitrified brick)." I may add, that in several specimens which have been exhibited in England and in France, this natural covering has been very distinctly developed over the whole body. Both the elephants at Paris have hair, and I now possess hair from the *mane*, or neck, of the Asiatic specimen, of five or six inches in length, and close set. This hair is so precisely similar in colour and consistency to that of the mammoth of the Lena, that the one can scarcely be distinguished from the other, except in length.

tusks and other bones, came into the collection of one private individual, in the course of a few years, who states, in describing the situation of the deposit, that the fishermen on that coast had dredged up great numbers of them, and sunk them in deeper water, as they greatly impeded their nets, in dredging for oysters! Now, if we were desirous of pointing out any *one* strong point in the phenomena of the earth's surface, which should seem, more conclusively than any other, to corroborate the Record of a general deluge, we could not desire one more remarkable than the fact of the remains of *innumerable elephants being scattered over the earth, invariably confined to the superficial diluvial beds;* but so far from being peculiar to such tropical latitudes as they must have inhabited when in life, that we now find them not only in every latitude, from the equator to the pole, but also at every degree of elevation from the sea's level, up to the Alpine plains of Mexico, and the glaciers of the Himalaya!

I must now advert to another class of fossil deposits, which has given rise to much discussion among scientific men, although, on an enlarged and general view of the whole question, there appears to be a close analogy and connexion between it and the diluvial beds above described. This class consists of very numerous instances in which fossils, almost similar, both in the species to which they belonged, and in their connexion with the superficial beds of diluvium, have been found in certain caves and fissures by which some calcareous strata are peculiarly characterized. These cavities vary in size, from narrow and tortuous fissures of only a few inches in width, up to caves of vast extent and depth: they all either still have, or formerly have had, some open communication with what is now the upper surface of the country, and, consequently, with its diluvial covering. The smaller fissures, and even some of the larger cavities, are frequently filled with it; while nearly all these caves exhibit more or less of such sandy or gravelly deposits, which have, also, evidently been modified by the action of water.

To a general reader, it may seem strange and unaccountable, that any hesitation should have been expressed, in attributing to the very same aqueous agency, the remains of animals *so identical in species* as those which occur in the caves, and in the general diluvial beds. He might imagine that if the *diluvium*, which is said so universally to overspread the earth, really owed its origin to a general flood, there could be no great cause of wonder if some of these cavities were more or less filled with it. He might further add, that if the prevailing waters of this deluge, with their heavy load of sand and mud, and with their due proportion of lighter animal remains, really drained past these open cavities, in the sides of the new valleys, it could excite no great surprise that a portion *of both* should have been caught as in a net, and there been deposited, as we now see them, in the deepest and narrowest recesses of the caves and fissures. Such doubts have, however, not only been expressed by able men, but most popular theories have been advanced to account, in a different manner, for the fossil contents of these cavities. Of the numerous bone caves and fissures, which have been more especially described, those in Franconia, in the south of France, and in England, have excited the greatest share of attention. In some, (as, for instance, those in Germany), the remains of *bears* were found to be most abundant; while in others, (as that of Kirkdale, in Yorkshire), the bones and teeth of hyænas seemed to show that they had outnumbered all the other numerous animals, the remains of which were, however, *in both instances*, mixed up with them. In the pre-conceived idea, that *the existing lands* were habitable, and inhabited before the flood, and that bears and hyænas naturally lived, in a wild state, in the same gregarious manner which they are sometimes made to do in our menageries, the supporters of the theory in question thought it beyond a doubt, that, in such instances, the caves had, for many ages, been the common dens of these animals, and that the quantities of the broken and detached bones of these two species had been thus gradually accumulated by *natural mortality*, under the feet of the surviving individuals. As for the great bones of the elephant, the rhinoceros, &c., they, being detached, (as is usual in the diluvial beds), were accounted for, as having belonged to animals inhabiting the neighbouring forests, who had been torn piece-meal by the voracious bears and hyænas; and their detached parts dragged, even into the innermost recesses of the *dens*, notwithstanding the unwieldy nature of the load, and the comparative weakness of these (supposed gregarious) wild beasts. It is true, that, in cases where the *heads* of these huge animals were found, it was difficult to account in this summary manner, for their presence in deep cavities, often of precipitous access: and in one remarkable instance, the entire carcass of a rhinoceros was found, in a limestone cave of considerable depth in Derbyshire, together with the bones of deer, &c., and a great mass of diluvial sediment and gravel. In this ingenious theory, which obtained an almost general sanction, from the very able and agreeable manner in which it was described, and the seemingly conclusive proofs by which it was supported, it was overlooked, or forgotten, that the ablest naturalists describe both the bear and the hyæna as so far from *gregarious* in their domestic habits, that they carefully shun the society of their own species, and lead a retired and solitary life. The bear usually hibernates for some months in the year, shut up in some *small* and generally *artificial* lair, contrived for warmth, dryness, comfort, and cleanliness: and none of his species are allowed to associate with him, except the young with their dams, to the number of one or two[*]. In no respect, then, could such spacious caverns as those in Germany, admit of the comforts so desirable to the bear. Nor is it in the least degree more agreeable to the natural instincts of the hyæna, to suppose him capable, savage as he may be in a wild state, of leading such a life of cold and dampness, as the above theory would denote. These animals are not gregarious; they prepare in spring, like wolves and foxes, a comfortable *burrow* for their expected litter, in the cleft of some rock, or in the face of some dry and sunny bank; and this burrow is jealously defended against all intruders, even of the same species. As soon as the young are old enough to provide for themselves, the whole family decamp; and during the remainder of the year, the hyæna lives the marauding life of a bush-ranger, devouring his prey on the spot where it is killed, and never dragging it into dens or burrows, except during the short time when he is occupied with his young[†].

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[*] See *Lloyd's Northern Field Sports*, and other works on the Bear.

[†] Indian and African sportsmen, with many of whom I have conversed on this subject, seem unanimous in their opinions, with respect to these habits in the hyæna; while Mr. Lloyd, and others who have had the best opportunities of becoming acquainted with the natural habits of the bear in its wild state, confirm the common opinion of naturalists, that all that family are of a solitary and retired character. Were it otherwise, the existing limestone caves in Norway, Russia, &c., would now be found to resemble those containing the fossil deposits.

But while these and other testimonies in support of some great and unusual convulsion, were, from year to year, brought to light, the idea of a Universal Deluge was warmly combated by many philosophers, who, striking at the very root of the subject in debate, denied the *possibility* of such an event. To this strong objection, it was not easy on the part of the diluvialists to reply, in accordance with the established laws of nature, on which alone, it was insisted, a satisfactory theory should be based. The strongest arguments in its favour spoke more to the *fact*, than to the *mode* by which it was brought about. The existence, in the most elevated Alpine heights, of beds of water-worn materials, containing fossil remains of elephants and other unwieldy animals, precisely similar in character to those seen at the lowest levels, spoke volumes in support of the *fact*, that a powerful force of waters had recently acted, where no rivers are to be found; and that animal bodies, which these waters could alone have moved, had been lodged on heights so lofty, and often so precipitous, as altogether to preclude the idea of their having lived and died there. The contemners of the idea of one *general* flood, could not gainsay these speaking proofs of some convulsion: but they argued that, in the course of innumerable ages, many minor convulsions, arising from volcanic agency, had left their marks upon the earth; and that by partial and local floods, all the above-detailed phenomena

Necessarily during Cooling of earth, & expansion & Contractions, there must have been much & frequent, for ages, of rise & fall, as seen in sea fossils on high mountains especially of the large trees of California

But the coal of vegetation growth, much under sea level, with subsequent deposits of lime & fossils from Sea life. & many of such things defeat this man's modern idea. of effects of flood, purely imaginary to meet the delusive language of present translation "of the whole earth" now designate mean (universal might, without much difficulty, be accounted for. To such partial deluges, they attributed those traditions so prevalent among mankind, in the distant corners of the globe. The idea was started, of the bursting of inland lakes during earthquakes, by which a dreadful, though merely *local,* havoc could not fail to have arisen*: nor was it looked upon as a satisfactory reply, that no symptom of such bursting, could be distinguished in existing lakes, in any part of the world. The sea was also described as having possibly rushed upon the land, and a reciprocal change as having frequently taken place between the two, on the strength of those minor local inroads which are known to occur, either during earthquakes, (as at Lisbon, in Jamaica, &c.) or during severe and long continued storms, (as in the instances recorded of Romney Marsh, and other low districts in England†.) Such arguments, although they could not satisfactorily account for the above proofs of universal aqueous agencies at high levels, had yet the merit of being supposed to be within the sphere of the laws of nature, which certainly could not be said of the fact advocated by the supporters of a general deluge.

But in addition to all the above-named objections to the literal interpretation of the Mosaic narrative respecting the flood, another, and an admitted diffi-

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* *Principles of Geology*, Vol. III., p. 270, &c., first edition.

† Ibid, p. 271.

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translation "of the whole earth"
now designate mean Universa

culty was constantly advanced, and one which still remains a stumbling block, in the way of many diluvialists, who have not yet been satisfied of the truth of some recently discovered facts, which entirely remove that difficulty. This was, the alleged total absence of the fossil remains of *the human race*, from the vast accumulations of other animal remains, which had been found scattered over the surface of the earth. To this very material objection, a consistent reply was found to be extremely embarrassing: for if the Mosaic statement was to be adopted in its full extent, it could not but be admitted that the earth had already become peopled before the flood; and as the whole human race, except a few individuals, was described as having perished, there could be no conceivable reason why the bones of the dead should not be found, together with other, and even more fragile bones, of small quadrupeds and birds, which were frequently so abundant. It seemed to be looked upon as a conclusive argument, that because human bones had not yet been found, to which a strictly *fossil* character could be assigned, no such bones were in existence: and so strong did this objection appear, that even the most zealous supporters of the truth of the Mosaic statement, could not but hesitate in their opinion respecting it, when dwelling on this apparent inconsistency. But it was urged by the advocates of the Scripture statement, that although the remains of man might not yet have been found, in such complete affinity to those of quadrupeds, as to merit the character of true *fossils*, yet, although that circumstance formed a natural subject of surprise and of hesitation, the deficiency up to that period, by no means bespoke the *certainty* of the non-existence of the human race in a fossil state: that even supposing mankind to have become as numerous as would be natural, during the length of time said to have occurred between the creation and the flood, yet that there could be no proportion between *their* numbers and those of other living beings, at the period ascribed to that event. Man had been multiplied from *one pair*, was endowed with a long life, and came slowly to maturity; while, even if quadrupeds had also been created in single pairs, which appeared improbable, still they must have increased and spread with such amazing rapidity, that their numbers must have been incomparably greater, at any given period, than those of the human family; and, therefore, that in the case of a general destruction, we could not consistently expect to find the remains of *one* man, for those of many *thousands* of the lower animals*. Even at the present advanced period of the world, such would be the natural result, if the subject were viewed, on the broad scale of the whole earth. It was further urged, that both in respect to the short period of a few past years, and to the mere *specks* upon the earth wherein the search for fossils had been made, there was, as yet, no evidence sufficiently conclusive, to settle so important a question in the negative; for as the ruins of a deluge must have been scattered, without distinction, over the surface of what is now *sea*, as well as what is *land*, we must weigh, in the scale of probability, the whole unsearched globe, against those few trifling spots, with which man had already become acquainted.

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* Mr. Sharon Turner has given us much interesting information on the vast increase of the inferior races, which so imperatively calls for that wonderful law, by which one race is kept down by its fellows. "Rabbits," says he, "have young several times in the year, and generally produce seven or eight at a

Such were the arguments to which some diluvialists had recourse, in suspending their judgment for a time, on the question of human fossils. But that subject began at length, though slowly, to assume a different character: man's remains had, from time to time, been found in various parts of Europe, and in such juxta-position to bones that were admitted to be fossil, that it became at length not unfrequently debated, as to what precise epoch they might belong. In many cases, it seemed unquestionable, from the *entire* state of the skeletons, and from marks of art, in the manner of their deposition, that these bones

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time; so that in four years, one pair would, in theory, become the ancestors of a *million*. Brown rats produce twenty at a litter, and three times a year!"

belonged to ancient, but *post-diluvian* beings, who had accidentally died, or been fortuitously interred, in the vicinity of fossil deposits of quadrupeds. Other cases occurred, however, in which it required some force to make a distinction between the *detached* bones of both species, found buried in the very same soils. In the cave deposits, also, human remains were frequently found; and at length, a few years ago, some French geologists were so powerfully struck with the mixture of human and other bones, in some of the caves in the south of France, that a more strict scrutiny was instituted; and the results were published in a paper by M. Tournal, jun., of Narbonne, in No. 52 of *Annales de Chimie et de Physique,* from which the following is a short extract:—

In speaking of human remains, M. Tournal says, " The heads of the geological world would have it that they were, in all cases, *recent,* and *accidental;* and their opinions had the effect of deciding the point as a subject *unworthy of further discussion.* However, the discovery of the caves of Aude, of Herault, and of Gard, in the south of France, offers to the observer a crowd of human bones, and of ancient pottery, mixed up in the very same mud with those of hyænas, tigers, lions, stags, and a number of other animals of lost kinds. Attention was, therefore, again called to the subject, and MM. Marcel de Serres, Jules de Christol, and myself, after an attentive and conscientious examination, have come to the conclusion, *that all these objects are of the same date,* and, consequently, *that man was contemporaneous with the animals now lost from the surface of the globe.* Our conclusion was principally based on the equal alteration of the bones, and on the manner of their deposit in the caves. We have not hesitated, therefore, notwithstanding the repugnance which our observations may occasion, to proclaim our belief, *that man exists in a fossil state.*"

Important as the above admission is, on the part of any geologists who have carefully examined the facts on which it is, (as it were, unwillingly), forced from them, it must be looked upon by the advocates of the Mosaic narrative as still more important, coming, as it does, from men who profess opposition to that narrative, and who deny, in the same paper, that any thing is to be learnt, on this subject, from "*our most remote historic annals.*" They are entirely opposed to the idea of a general deluge; and speaking in praise of one of the most remarkable publications, in proof of that event, (the *Reliquiæ Diluvianæ* of Dr. Buckland,) they add respecting it, "*auquel on ne peut reprocher, peut-être, que le titre,*"—" whose title was, perhaps, its only fault." Instead of attributing the fossil remains of quadrupeds to so late a period as the creation of man, they jump to the conclusion, that man was of as remote antiquity as they had *previously* adjudged the lost quadrupeds to be; and they add, " it is true, that in giving to the human race *so great an antiquity*, we ought to feel surprise at not finding, in the annals of mankind, the traditions of violent convulsions which the earth has experienced. If history is *dumb* on these events, or if we only possess *the most vague and unnatural recollections of them*, it is because *traditions* diminish in distinctness, the further removed from the point of departure. We cannot, therefore, look into the history of the most ancient people, to discover the primitive annals of the human race. *Geology alone* can fill up the chain of past events; and it promises to furnish a complete supplement *to our short and imperfect annals**." It cannot justly be charged against the writer of the above passage, that his views were biassed by a desire to *corroborate* the Scripture narrative.

Passing over various other instances, in which human bones have been found in the immediate neighbourhood of fossils—as at Durfort, by M. Firmas; at Meissen, near Dresden; in numerous caves and fissures in England and Wales, detailed by Dr. Buckland, in his *Reliquiæ Diluvianæ*, &c.,—I shall proceed to mention the most conclusive instance that has yet occurred, in the idea that any

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* *Annales de Chimie*, February 1833.

one undoubted instance of *man, as fossil,* is as good as a thousand, for the purpose of establishing this long-contested fact.

The instance in question occurred at Köstritz, a small town in the beautiful vale of the Elster, in Upper Saxony. A very clear account was given of this deposit, in 1820, by the Baron von Schlotheim, published at Gotha, and translated from the German by Mr. Weaver, in the *Annals of Philosophy* for 1823. Dissatisfied, however, with the objections which had been urged against the expressed opinion of the Baron, *that "man was unquestionably found in a fossil state in this deposit,"* I myself visited Köstritz, and spent several days there, in the summer of 1834, for the express purpose of a careful examination of the locality, and the circumstances. I there had the advantage of the fullest and clearest information, from Dr. Schottin, of Köstritz, who had long resided there, and by whom the attention of M. von Schlotheim was called to the fossil deposits in the neighbouring gypsum quarries, from whence, *during the last fifty years,* human and other bones have been, from time to time, extracted. From Prince Reuss also, the proprietor of the quarries, and the possessor of some most interesting specimens, both human and quadruped, I received the kindest attentions, and every facility in prosecuting my inquiries. The tenant of the quarries, also, an intelligent and respectable man, who had personally assisted in some of the most interesting discoveries, pointed out to me, on the spot, the exact localities. Without entering into a full detail of the geological facts exhibited on this interesting spot, it may be sufficient here to state that the whole of this gently undulating country, is of the most smooth and rounded forms on the surface; that the quarries are of gypsum, used as lime, (but not at present worked); that they occur on the rising ground, on the left bank of the valley, and so far above the level of the river, as altogether to preclude the idea of the human bones having been *subsequently* mingled with the more ancient fossil bones, by any land-flood, or other local cause, which solution had been suggested as probable by Dr. Buckland, in alluding to the Baron's account of the fossils of Köstritz*. The whole of that country is rather deeply overspread with a diluvial covering of sand, gravel, and loam. In this diluvial loam, are pebbles of granite and of various other distant rocks. In viewing the locality of the gypsum quarries, it is quite certain that, before the ground was broken in upon, in search of that limestone, there existed, in that spot, *the same smooth and rounded forms which prevail universally around.* There was, therefore, in this instance, no open cavern, or superficial fissure, into which, as it might be thought, bones could have been *subsequently* dragged by wild beasts, or drifted by land-floods. Indeed the only running stream near, is the Elster, at about three quarters of a mile distant, and fifty or sixty feet lower in level, with a wide intervening valley, the whole of which must have been filled, from side to side, with water, before any land-flood could, by possibility; reach the situation of these quarries. It is clear, then, that the ground, previous to its being broken up in search of gypsum, had been undisturbed, ever since the period when

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* *Reliquiæ Diluvianæ*, p. 167. In his Bridgewater Treatise, Dr. Buckland is entirely silent on this instance of Köstritz. In again stating his general dissent from the idea of such bones being, in any case, *fossil*, he probably alludes, in the following passage, to the instances I have just referred to: "Several accounts have been published within the last few years, of human remains discovered in the caverns of France, and in the province of Liège, which are described as being of the same antiquity with the bones of hyænas, and other extinct quadrupeds, that accompany them. *Most* of these *may probably* admit of explanation, by reference to the causes just enumerated." — Vol. I., p. 106. These were, "the common practice of mankind, in all ages, to bury their dead in such convenient repositories," and the "savage tribes who had re-

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peatedly disturbed portions of soil, in which their predecessors *may have been* buried." This seems rather a summary mode of rejecting the opinions of other scientific men, upon such important facts, which it does not appear that the author had himself examined. However this may be, the idea will not in any degree affect the case of such remains of man as have been found at Köstritz, which is certainly the most unequivocal instance that has yet come to light.

that smooth and *rounded* surface, with its deep diluvial covering, had been imparted to that country; and as the bare rocks, on being stripped of this deep diluvial covering, have a very broken and rugged surface, it is equally evident that the *cause* of the diluvium, (whatever that cause might be,) was also the *agent*, in rounding off the forms of that deposit, and in moulding the upper surface of the country into its present gently undulating, and beautiful appearance.

After the removal of six or eight feet of this diluvium, the workmen reached the calcareous rock of which they were in search. This is described by M. von Schlotheim as follows: "At Politz, the upper quarry is extremely instructive, exhibiting wide fissures and caverns, *entirely filled* with the alluvial loam," (diluvium) "which covers the whole country, to a great extent. Considerable masses of stalactite appear in several places; and here, principally, were found those bones of large land quadrupeds, now in my collection. They were met with *at the depth of twenty feet, embedded in the loam of one of the wider cavities.* All the bones are more or less changed, and penetrated with calcareous matter. The condition of the greater part is nearly the same as that of the bones found at Gaylenreuth, Scharzfeld, and the other German bone caves; *and hence it seems probable that they were of an equal age, and referable to the*

same epoch of the ancient world. At Köstritz, the entire gypseous mass is intersected and perforated by fissures and cavities, which follow *every direction,* and are connected with each other *by serpentine channels,* of larger or smaller dimensions. *They are filled, throughout,* with the alluvial deposits, even to the greatest depth; and this loamy sediment appears to be deposited *horizontally,* for short distances, yielding, *in clusters,* as it were, and in precisely the same circumstances, a number of bones of land animals, *amongst which are disclosed to view, also, human bones.*" After some further descriptions of other fissures, and their fossil contents, the Baron, (who had an advantage which I had not, in seeing the working of the quarries, and of, himself, discovering the bones which he describes,) proceeds thus to sum up the evidence: "It is also evident that the human bones could never have been *buried* here, nor have fallen into the fissures in the gypsum, *during battles* in ancient times," (the human bones are few, and completely *detached* and *isolated,*) "nor have been thus mutilated and lodged by any other accidental cause in more modern times; inasmuch as they are always found, with the other animal remains, under the same relations; *not constituting connected skeletons,* but collected in various groups, in the deposits of loam, that occupy the fissures and cavities of the gypsum: they appear, therefore, to have been strictly *fossil, and to have been swept hither by floods,* with the other animal remains, *at the period of the formation of the alluvial tract itself.* It has already been remarked by Cuvier, that the epoch of a great deluge, by which many animals were destroyed, whose remains are now found *in alluvial*" (diluvial) "*tracts alone,* and not in any strata of an earlier era, nearly coincides with our chronology; and the traditions of such a deluge, preserved among all nations, *now appear confirmed, by the instructive documents at present lying before us.*"

Strong as my own impressions formerly were on reading this account, they were increased to the fullest conviction of the truth of it, on visiting the spot, and on witnessing, not only the conclusive geological phenomena presented by the general view of the valley of Köstritz, but also on examining fine specimens of the human and other bones, which had been found in the tortuous fissures of the rock. Of those of quadrupeds, M. von Schlotheim enumerates those of the rhinoceros, the lion or tiger, the hyæna, the horse, the ox, the deer, the hare, and the rabbit; as also the bones of the owl, and other birds. Since the period when he wrote (1820), other bones have been found, and amongst them, those of a small elephant, of which I saw the tusk, in the collection of Dr. Schottin; it was but eight or nine inches long. The bones of the elk and the *reindeer* have also been since identified; and it is scarcely necessary again to call the attention of the reader, as an extract from Cuvier, already quoted, must have done, to so obvious an anomaly as the mixture of the remains of the latter, with those of the elephant and the rhinoceros, which never could have occurred, but for the confusion arising from some such event as a general deluge; since the structure of the feet and bones of the reindeer, obviously bespeaks the snowy regions for which, alone, it is best adapted; latitudes quite unsuited to such luxuriance of vegetation as the other unwieldy animals must necessarily have required for their sustenance.

The specimens of the bones of *man*, seem here to be dispersed in the diluvium, exactly in that small proportion which we should naturally have expected. While the bones of quadrupeds have been found here in great abundance, those of the human species do not amount to more than about twenty specimens. Some of these were collected and retained by M. von Schlotheim, after whose death, they were placed, as I was informed, in the Museum at Berlin. Of these, he mentions fragments of the arm and thigh bone of man, as having been found by him at the depth of eighteen feet from the surface of the country, and "*eight feet deeper than two phalanges of the rhinoceros.*" Other single specimens are seen in the private collections of the neighbourhood of Köstritz. A portion of a human cranium, and of a leg bone, have also been procured for the British Museum, and may be seen in the same case, as the more entire specimen found at Guadaloupe, which has now, at length, been placed in a situation suited to its high interest and value. The above two bones are marked with the name of Dr. Schottin. In the possession of Prince Reuss, I saw a fine specimen of the rib of a young person, about fourteen or fifteen years of age, from which I made a drawing the size of nature; as also of two bones, which excite the deepest interest in the mind, and which now belong to Dr. Schottin. They consist of the *tibia* and the *radius* of an infant, or infants' of not more than three or four months old, and only from three to four inches in length.

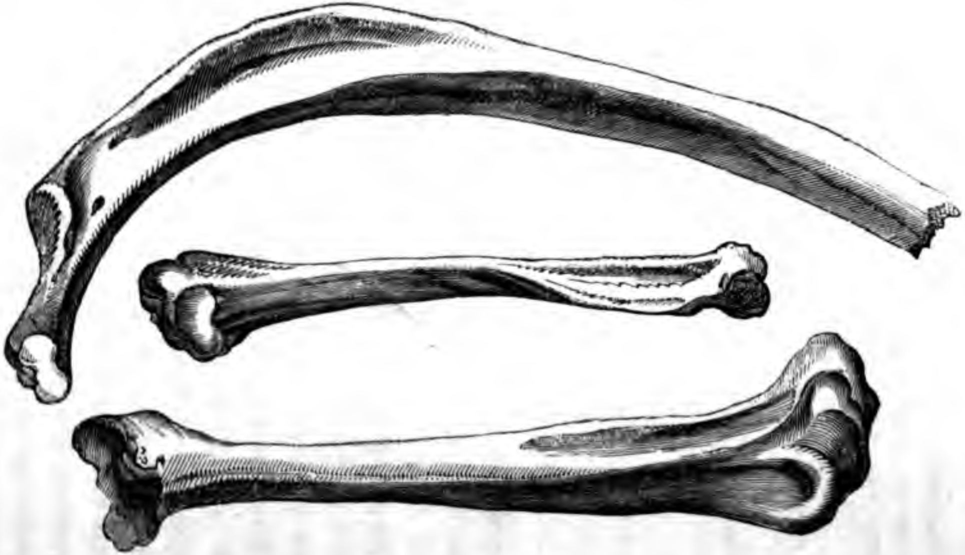
Description of the Wood Cut.

No. 1.—The *Radius* of an infant of not more than three or four months old; drawn from nature, and of the natural size.

No. 2.—The *Tibia* of an infant of about the same age as that of No. 1; also drawn from nature, and exactly of the natural size.

The above two specimens are in the collection of Dr. Schottin, of Köstritz; but I am not aware of their having been found *together*, or so near to each other, as to lead to the inference that they belonged to the same body. They are in very fine preservation.

No. 3.—A *Rib* of a young person of the age of about fourteen or fifteen years, the size of nature, and drawn from the specimen itself. It is in the collection of Prince Reuss, the proprietor of the district; and it was described by Dr. Schottin, in No. 4 of the *Isis*, of Leipsig, page 415 (1829).



No. 3.

No. 1.

No. 2.

It is unnecessary to dwell upon the obvious inferences which naturally flow from the conclusive evidences, both of the *fact* of some destructive deluge, and of the existence of man *previous* to it, which are here exhibited in the fossil phenomena of the Köstritz quarries. "The fact," says Cuvier, "of the extinct species of hyæna being *common to the gravel beds and caves* of France, Germany, and England; and of *bears occurring in the diluvial gravel* of Upper Austria, Würtemberg, and Italy, proves both these animals to have been the anti-diluvian contemporaries of the extinct elephant and rhinoceros." Upon the very same principle ought we to judge of the relative antiquity of the bones found at Köstritz. Other instances extremely similar have been described, although, by previous theory (opposed to *man as fossil*), they have generally been overlooked, or otherwise accounted for. Thus, in the year 1786, human bones were found in the fissures of a limestone quarry near Kirkby Moorside, in Yorkshire. These fissures are described as having been from one to six feet wide, and of great depth; they were filled, from top to bottom, with diluvial loam, very similar to that found in many of the bone caves. It cannot, of course, be now ascertained, of what exact character these human bones were; but, when the fact of *human fossils* has been, in any single instance, completely proved, as at Köstritz, future discoveries of such remains, in connexion with deposits avowedly fossil, will merit more candid inquiry and attention than some former instances have received from geologists.

Such, then, up to the present period, is the evidence which has been adduced in opposition to the oft-repeated assertion, that *man* has never yet been discovered in a fossil state; and that, consequently, doubts may consistently be entertained, as to his *existence*, previous to the event which proved fatal to so many other living beings. But facts, even of this simple and conclusive nature, do not work on the public mind with much rapidity. Sixteen years have now elapsed since these deposits were scientifically described by M. von Schlotheim; and yet, so incredulous are most of us, on points to which our pre-conceived notions are opposed, that, at the time when I now write, there is scarcely any geological writer who has noticed the occurrence, except with the view of giving a different turn to the opinions expressed with so much candour by the Baron. Nor can I deny to others, the feelings to which I myself formerly laid claim: for without in the slightest degree doubting the truth of the facts described by him, nothing short of that *personal* examination and attention, which I have since bestowed upon the locality, could have brought me to that entire conviction of the existence of FOSSIL MAN, which I at present entertain.

Such is a slight general outline of the facts and arguments, by which the opinions of men have long been kept wavering, on this important subject of the

Mosaic Deluge. During the short, but active, existence of the new science of geology, we have frequently seen men of the ablest minds, come to directly opposite conclusions upon the very same facts. We find the learned author of the Sixth Bridgewater Treatise, obscurely hinting, in the only passage in which he even *alludes* to this great instance of "the Power, Wisdom, and Goodness of God," that the evidences of the Mosaic Deluge, which once appeared so clear to him, had now either lost their lustre, or been entirely erased from his mind. In a former work, we find the following clear and well drawn description of the effects of a universal flood of waters:—"An agent thus gigantic, appears to have operated *universally* on the surface of our planet, at the period of the Deluge; the spaces then laid bare, by the sweeping away of the solid materials that had filled them, are called *valleys of denudation;* and the effects we see produced by water in minor cases, prepare us to comprehend the mighty and stupendous magnitude of those forces, by which *whole strata were swept away, valleys laid open, and gorges excavated,* in the more solid portions of the substance of the earth, bearing the same proportion to the overwhelming ocean *by which they were produced,* that modern ravines on the sides of mountains bear, to the torrents which, since the retreat of the Deluge, have created, and continue to enlarge them."—*Reliq. Diluv.*, p. 237. In a note at page 94 of the Bridgewater Treatise, however, this author draws a distinction between two great events, one of which he terms "the *last* of the *many* geological revolutions that have been produced by violent irruptions of water," and by which, he now thinks, the above-described effects were produced; and the other being "the *comparatively tranquil inundation*, described in the Inspired Narrative." He thus proceeds: "It has been *justly* argued, against the attempt to identify these two great *historical* and *natural phenomena*, that as the rise and fall of the waters of the Mosaic Deluge are described *to have been gradual, and of short duration*," (the whole event is described as having occupied more than *twelve months*,) "they would have produced comparatively little change on the surface of the *country* they overflowed."

It is difficult to conceive any aqueous convulsion that would not be *gradual* in its rise; and more especially one which lasted during so *short* a period as *a whole year*. Where the learned author of this passage found, in the Book of Genesis, the description of the *tranquillity* of the waters of the flood, I have not been able to discover. Scripture, it is true, does not *describe* the agitations, both from tides and currents, which could not but have existed during the prevalence of a flood that covered the highest hills; or the stupendous force of "the ocean pouring in over the land, when its level was destroyed*." This is left to the conception of the reader, who may be supposed to be aware of the unavoidable *absence of tranquillity*, on the occurrence of such an event*. The illustrious Cuvier held a very different opinion; and we find him thus expressing himself upon this subject:—"I conclude with M. De Luc, and M. Dolomieu, that if there be any fact well established in geology, it is this, that the surface of our globe has suffered *a great and sudden revolution*, the period of which, cannot be dated further back than five or six thousand years. This revolution has, on one hand, *ingulphed, and caused to disappear*, the countries formerly inhabited by *men*, and the animal species at present best known; and, on the other, *has laid bare the bed of the last ocean*, thus converting its channel into the present habitable earth."—*Disc. Prélim.*

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* *Reliquiæ Diluvianæ*, p. 237.

Such was the conclusion to which this philosopher was led by his extended geological studies, and such the correspondence which he perceived between *history* and *facts*, without his having any particular view, however, towards the establishment of such corresponding testimony. And yet we are now called upon, by the most recent geological writers, to renounce this *sacred error*, and so to modify the Mosaic statements, as to bring our ideas of the flood within the more limited bounds of the laws of nature, and to regard it as some merely local volcanic convulsion, of which, the ignorance of primitive times has given rise to an inflated and improbable account. " In an early stage of advancement in knowledge," says one able writer, " when a great number of natural appearances are unintelligible, *an eclipse, an earthquake, a flood,* or the approach of a comet, with many other occurrences afterwards found to belong to the regular course of events, are regarded as prodigies. The same *delusion* prevails as to moral phenomena, and many of these are ascribed to the intervention of demons, ghosts, witches, and other immaterial and supernatural agents. By degrees, many of the enigmas of the moral and physical world are explained; and instead of being due to *extrinsic* and *irregular* causes, they are found to depend on fixed and invariable laws. *The philosopher at last becomes convinced, of the undeviating uniformity of secondary causes;* and, guided by his faith in this principle, he determines *the probability* of accounts transmitted to him of former occurrences, *and often rejects the fabulous tales of former times,* on the ground of their being irreconcilable with the experience of more enlightened ages."—*Principles of Geology*, Vol. I., p. 86.

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* It seems, from the obscurity of the note above referred to, as if its author was unwilling to avow the full extent to which he now evidently subscribes to the prevailing geological opinion on this subject, by which the *universality* of the Mosaic Deluge, (if such deluge is admitted at all,) is reduced to the limits of some merely *local land-flood*, which "would produce but little change on the surface of the *country*," (or local district,) which it overflowed.

See also *Principles of Geology*, Vol. III., p. 270.

"In speculating on catastrophes by water," says the same author, "we may certainly anticipate great floods *in future*, and we may therefore presume that they have happened again and again, *in past* times*." It is not a little singular, that in speaking of floods of the *past* and the *future* eras of geology, he should be able to adduce no greater instance of such floods in the *existing* era, than the merely local overflowing of rivers by rain, or melting snow. We have not even one solitary example adduced, of a lake, exhibiting the smallest prospect of bursting its boundaries, which is one of the favourite hypotheses of geology, and to which the above remark applied, in reference to the North American lakes, which are always quoted as instances, in illustration of the probable nature of the flood mentioned by Moses. In another part of the same work, this author thus speculates on such floods. "They who have used the terms *anti-diluvian* and *post-diluvian*, proceed on the assumption, that there are clear and unequivocal marks of the passage of a general flood over all parts of the surface of the globe. It had long been a question among the learned, even before the commencement of geological researches, whether the deluge of the Scriptures was *universal*, in reference to the whole surface of the globe, or only so with respect to that portion of it, which was then inhabited by man. *If the latter interpretation be*

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* *Principles of Geology*, Vol. I., p. 101.

admissible, the reader will have seen, in former parts of this work, that there are two classes of" (natural) " phenomena in the configuration of the earth's surface, which might enable us *to account for such an event.*" I cannot help interrupting, for a moment, the course of this hypothesis, to remark the singularity of an *accidental* land flood, being extended *exactly so far* as to include the habitations of *the whole human species.* " First, the bursting of extensive lakes elevated above the level of the ocean; and secondly, large tracts of dry land depressed below that level. When there is an immense lake, having its surface, like Lake Superior, raised 600 feet above the level of the sea, the waters *may be suddenly let loose,* by the rending or sinking down of the barrier, during earthquakes, and hereby a region as extensive as the valley of the Mississippi, *inhabited by a population of several millions, might be destroyed.* On the other hand, there *may* be a country placed beneath the main level of the ocean, as we have shown to be the case with part of Asia; and such a region must be entirely laid under water, *should* the tract which separates it from the ocean, *be fissured or depressed* to a certain depth. The great cavity of Western Asia is eighteen thousand square leagues in area, and is occupied by a considerable population. The lowest parts, surrounding the Caspian Sea, are three hundred feet below the level of the Euxine; here, therefore, *the diluvial waters might* overflow the summits of hills rising *three hundred feet* above the level of the plain; and if depressions still more profound, existed at any former time in Asia, the tops of still loftier mountains *may have been* covered by a flood*."—*Principles of Geology*, Vol. III., p. 271.

Such is the line of reasoning by which the distinct testimony of Inspiration is to be set aside, on the subject of the Deluge; and such the steps, whether *intentional* or *casual*, by which, if acceded to, all confidence in Scripture must eventually be shaken, on subjects of infinitely greater importance than that which we are now examining. 'A natural deluge, arising from physical causes, within our view,' says geology, 'may be readily understood and assented to; and of such local convulsions we have numerous proofs, in the strata of the earth; but to a *universal flood*, such as Moses describes, we cannot subscribe, because we can conceive no law in nature, by which it could possibly be effected.' It may readily be admitted, that, as a general rule, this determination of adhering closely by the established laws of nature, is most necessary and wise; for, without such rule, human ardour, combined with human blindness,

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he [illegible]

[*] "*And all the high hills that were under the whole heaven were covered*," "*and the mountains were covered*."—Gen. vii. 19, 20. If, to this, we add the fact, of the Ark being stranded on the tops of Arrarat, which is known to be a ridge of great elevation, we shall acquire some idea of the true value of the above argument. We must, however, in candour, remember, that the whole passage is merely hypothetical, and altogether depends upon the opening words "*if the latter interpretation be admissible*."

would recur, in every difficulty, to a *final* cause. But "although it be *dangerous* hastily to have recourse to final causes*," yet there are some subjects, and those too, not unworthy of philosophic attention, which cannot possibly be credited, without drawing a certain line of exception to this rule. Is the chymist in his laboratory, for example, to refuse his assent to the statement of History, with regard to the physical fact, that, on one occasion, *water* was converted into *wine*, merely because he is certain that the laws of chymistry would not enable *him* to succeed in any similar trial? Is the physician or surgeon to put in the plea of the laws of nature, in objecting to the no less physical facts, respecting the *blind* being made *to see*, the *deaf to hear*, the *dumb to speak*, and even *the dead body*, on which corruption had begun its work, *to rise again into life*, and once more to resume its former station in human society? Is the historian to refuse his belief to the fact of events having been foretold, merely because such power has never come within his own experience? On similar grounds might the soldier refuse his assent to the statement of Joshua respecting the destruction of the walls of Jericho, on the strength of his never having either seen or heard, in modern warfare, of walls being destroyed by the mere shout of a besieging army. We can, in short, see no bounds to scepticism on such subjects, from the moment that we subscribe to any such objections, however talented they may be, who set us the example. If these, and such like statements of physical facts are to be erased from the Word of God, as being altogether inconsistent with the common laws of nature, then, indeed, *but not till then*, will the Christian geologist be justified in entertaining doubts with respect to the fact of a general Deluge, on the plea of his inability to account for it, by the fixed laws of nature. We not only have that fact recorded, with as minute precision as is to be found in the description of any of the cases just alluded to; but we are also informed of the great moral *cause*, on account of which the earth was so severely visited. The statement must be either altogether *true*, or altogether *false;* we cannot hesitate between these two alternatives. If, on the one hand, we suppose it *false*, then has our Blessed Saviour himself aided in promoting the belief of that falsehood, by distinctly alluding both to the *fact*, and to the *universality* of its destructive consequences to mankind*. If, on the other hand, we suppose it *true*, in the literal sense of the Mosaic statement, (to which our Saviour so unequivocally refers,) then must we conclude that those geologists are in error who withhold from it their credence, solely because nature and its laws will not sanction such assent. We may safely leave it to every Christian reader, to decide for himself, so simple an alternative. We must act with due consistency with regard to such decisions as are here demanded from us. We cannot *believe* one of the above preternatural, yet physical, facts, and *deny* another, simply because we have not discovered the means by which that other was effected. If it can be clearly shown, from natural facts, as I hope to make it appear, that a great change occurred, over all the present dry lands of the earth, at the very period assigned by history to the Mosaic Deluge; and if the known laws of nature will not, or cannot, furnish us with any means of explaining how this change was effected; we must, *perforce*, admit into our scientific reasoning, a *preter*-natural power and agency; and thus attribute to the power and will of nature's God, what nature itself can by no means account for.

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* *Bridgewater Treatise on Geology*, Vol. I., p. 547.

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* *Matthew* 24 ~~xxx~~i. 38 and 39; *John* v. 47.

att. 24, 39. Christ [illegible]
but taking all. meaning v. 34 of the [illegible]
generation [illegible]

Before concluding this introductory chapter, I shall now avail myself of this opportunity of shortly stating what my own opinions have been on this subject, previous to the disclosure of the new and conclusive evidence which is now to be described; and of pointing out some important errors into which I have myself fallen, in the "General View" of the science, with reference to Scripture, which was published some years ago. That work was undertaken in the desire of refuting a line of theory, which I then thought, and which I still think, erroneous; and tending directly to the subversion of that confidence in Scripture, which is the only main-stay of man, in this fitful and ever-changing scene below.

It has been said, (and it is easier said by the cool looker-on, than by him who, himself, enters into the debate,) that in subjects of such importance, the publication of ideas, in any degree crude or imperfect, is in a high degree injudicious; and that it is better patiently to wait until the theories of eminent men have passed through the crucible of ~~time, or~~ been fined down by the rough friction of public opinion. Had this course been followed by a great majority of those geological writers, who have written, and subsequently recanted, upon the evidences of the science, we should, at the present time, have been much further removed from the discovery of the truth, than we now are, however distant we yet may be. On the contrary, nothing is so conducive to the elucidation of that truth, of which, we must presume, all are in search, as the fullest and freest discussion, if carried on with candour, and provided the subject in debate, come within the grasp of human intellect. Truth is only to be found in a patient and temperate examination of well attested facts, detailed without warmth, and without bias. At the period of the publication in question, I had *read* of nature, more than I had studied from the original, although that original had not been altogether neglected. During several years that have since elapsed, I have reversed this plan, and have applied myself with ardour to the study of geological *facts*, both in Britain and on the Continent. The result has been a speedy correction of various errors into which I had inadvertently fallen; and on which I had ventured to differ from more experienced practical observers. In a desire to vindicate Scripture upon points which geological theories had invaded, I fell into the too common error of pushing even a sound argument too far; and of thus attributing to Diluvial action alone, formations which I have subsequently found, must have been in existence, as solid rocks, before the period of that event. I was, however, firmly persuaded, that the General Deluge, so much contemned by many scientific men, was an event which not only really took place as described, but one so vast in its necessary effects, that its omission from the theories of this new science, could not but be productive of obscurity and error. By persevering in this conviction, though opposed by the judgment of so many more able men than myself, I have, at length, been rewarded by the discovery of such proofs, both of the *fact*, and of its *recent* occurrence, as well as of its having been the *only* event of the kind to which our globe has ever been subjected, that I hope now to be enabled to place the subject on its true footing; and to bring to the minds of all candid inquirers after truth, who may peruse this volume, the same full conviction respecting it, which I myself now entertain. Instead of such general and circumstantial testimony, (strong though that was,) by which, alone, the subject could, hitherto, be attested, we now have natural proofs, amounting to mathematical demonstration, of the *origin* of our own island, and of the other dry lands of the earth, at a period which exactly corresponds with that of the Mosaic Deluge; and we can, therefore, no longer doubt that an event of most unusual magnitude then occurred, by which the ancient seas and lands were transposed; and that in a manner far beyond the powers of any of the existing laws of nature.

It is now only necessary to add, that the main object of this treatise is confined to the exhibition of these new proofs. I shall have no need of further allusion to the corroborative testimony of ancient traditions; nor need I again dwell upon the still more valuable testimony of Scripture itself. The proofs now to be produced are drawn exclusively *from nature;* and the inferences drawn from them will be strictly confined within the laws of severe philosophical induction. But I must request the reader to bear in mind, that it is not the *mode* by which this great change was brought about, with which I have now to deal. The occurrence of the *fact* is all that I can hope to prove: and I must leave to geologists who adhere strictly to the laws of nature, the task of explaining, as they best can, in what department of *existing nature,* we are to look for the source of such powerful and tremendous agency.

CHAPTER II.

GENERAL OUTLINE OF THE SUPERFICIAL FORMS, AND OF THE GEOLOGICAL STRUCTURE, OF THE EXISTING DRY LANDS.

On entering upon the study of so vast a subject of speculation as the destruction and renewal of the habitable parts of the globe, it is desirable that we should commence by taking a general and extended survey of the existing dry lands, for the purpose of pointing out that striking uniformity of character, and outline, into which they have all been, more or less, moulded; and of fixing the attention upon such of those features as may seem, from their more frequent occurrence, to have resulted from *the general rule*, as it were, of nature, instead of permitting what might, in like manner, be termed the *exceptions* from that rule, to exercise an undue influence over our minds. Almost every one has experienced the delight of quitting, for a time, the dull, though fertile, plains, or the gently undulating hills of his native district, in search of a lighter and purer air, and scenes of a more spirit-stirring character, among the more elevated mountain ridges which are thinly sprinkled over the earth. Such persons, whether scientific or otherwise, have felt how powerfully their attention has been aroused, by the natural phenomena, as well as by the romantic beauties, which are there displayed before them. We look back from thence with comparative indifference, on the monotony and dulness of the plains below; and so deep and lasting are the impressions of delight to which these Alpine scenes give rise, that we are too apt to look upon the limited districts in which they occur, as of much greater importance and interest, than the more humble plains which lie spread out beneath them. But pure as is the air, and invigorating as are the scenes, which are there to be found, it is not such air, nor such scenery, in the midst of which the great mass of mankind are doomed to pass their lives. Happily for the human race, whose sustenance and welfare so materially depend upon that admirable order of nature which now exists, we find that by far the greater proportion of our existing continents and islands, are spread out into smooth and gently sloping forms, but little elevated above the common level of the waters, and thus possessing not only such forms, but also such temperature, as are best suited to that laborious culture, by which man has become doomed to earn his bread by the sweat of his brow. Had the greater part of the habitable surface of the earth been composed of such picturesque mountains, and romantic rocks, as constitute the comparatively narrow ridges of the Andes, the Alps, or the Himalaya, it is certain, not only that the numbers of the human race must have been infinitely inferior to what they now are, but that the greatness and prosperity of nations must have been extremely limited; while both the objects of commerce, and the easy means of transport, whether by roads, or by inland navigation, must have been almost entirely wanting. Instead of fertile plains, covered with a variety of alluvial soils, and watered by gently flowing streams, thus offering to mankind every possible inducement to settle on, and cultivate them, we should have seen only arid slopes, too steep for the plough, and torrents so rapid, as to be altogether unsuited to navigation. Instead of enjoying that mild and humid temperature, so prevalent in the lower regions of the atmosphere, and by which the vegetation of the plains is so materially benefited, we should have been subjected to all the severities and vicissitudes of Alpine regions, where it requires the utmost exertion of human toil and industry, to support a poor, and generally a very limited, population.

On viewing, therefore, on an enlarged scale, the superficial forms and outlines of any country, we find that the extent of the mountainous districts bears but a very trifling proportion to that of the plains which generally surround them on all sides. In our own island, which, though small, may be regarded as a complete epitome of an entire continent, we find the highest districts occupying but a very limited space compared with the whole, although that proportion is still infinitely larger than in France, Germany, or Russia. We find that, with the exception of some parts of Cornwall and Wales, the whole southern portion of the kingdom is one continued plain, of but small elevation in its highest parts, and only varied by the innumerable valleys which have been grooved out upon its surface, and which form the drainage for the easy flow of its superfluous waters, on all hands, towards the ocean. The midland and northern parts of the kingdom exhibit a greater elevation, in that central ridge of smooth and rounded heights, from which the rivers flow to the east and westward, to the sea. But even these heights are scarcely deserving of more than the name of elevated parts of the general plain; and only derive importance, in point of elevation, from the narrowness of the island towards the north of England. In Ireland we also see a beautiful model, in miniature, of an entire continent, though of a more solid and regular form. Its smooth and rounded mountains are no where raised to any great elevation; they prevail more particularly, towards the southern and western parts of Munster, with the exception of which, almost the whole island may be regarded as a table land of but small elevation, intersected deeply by innumerable valleys, in which lakes and rivers remarkably abound; the drainage of these waters pointing, as in England, *on all sides*, to the exact level of the sea.

From these miniature models, if we cast our eye over the broad expanse of the neighbouring continent, we find one uninterrupted plain of almost uniform elevation, from the heights near Calais, across the continent of France, Germany, Poland, and Russia; nor does the mind's eye find any long pause, even at the limits of Europe, to the eastward. A similar table-land is found spread out over the interminable breadth of the north of Asia, broken only by the narrow ridge of the Oural Mountains, which forms the natural boundary between Europe and Asia to the North. In the southern parts of Asia we find, it is true, some of the most lofty pinnacles of the globe, in the mountainous ridges which there divide the plains; but extensive as these elevated regions in themselves are, they are incomparably more limited than the breadth of plains which are spread out, on all sides, beneath them. Throughout the whole of these vast steppes, or table lands, the flow of waters, and the more or less rapid currents of the streams, form the true criterion by which we may judge of the degree of inclination which the face of the dry land presents. Thus, we may judge of the plains of India, by the gentle and navigable current of the Ganges, the Indus, and the Burrampooter; of Siberia, by the currents of the Lena, or the Irtish; of European Russia, by the streams of the Volga and the Dnieper, with their innumerable tributaries; of Germany, Hungary, and Turkey, by those of the Elbe, the Rhine, the Oder, and the Danube; while, in France, we find the Rhone, the Loire, and the Seine, with their tributaries, intersecting almost the whole kingdom, and presenting an immense extent of natural inland navigation. From these quarters of the globe, if we regard attentively what little is known of the interior of Africa, and of New Holland, we shall find a result precisely similar. Immense plains form the *general rule*; while the more limited Alpine ridges are but few and far between, having their boundaries and outlines usually well defined. If such are the distinguishing features of the Old World, they are seen yet more remarkably developed in the New. Throughout the whole of North and South America, there may be said to be but one important and well defined ridge of mountains. This, it is true, is the most remarkable and extensive to be found upon the face of the whole globe; yet, in point of extent, it bears but a small proportion to the enormous plains which lie spread out on its eastern side. The vast ridge of the Andes is prolonged throughout almost the whole length of the New World; and its most remarkable feature seems to be, that while to the westward it is, in many parts, so near the Pacific Ocean, as to throw off its waters almost immediately into it, by short and precipitous torrents, many of which only flow during the wet seasons of the year; on the eastward, its waters seek *the same general level*, in a prolonged current, of many hundred miles in extent; watering, in their gentle course, the vast plains which form the leading features in the American continent*.

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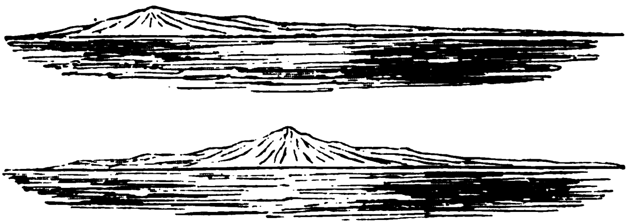
* Amongst numerous other works in which the superficial forms of the New World are clearly exhibited, a late publication of a distinguished American writer, entitled *Astoria*, gives a

We thus find, on every part of the habitable globe, that the general character and outline of the dry lands, consists of a *gently rounded, smooth,* and *slightly sloping* form, assuming, in by far the greater number of cases, the character of *a plain,* but little elevated above the level of the surrounding ocean; presenting a section somewhat like the following, and having such easy inclinations, as to discharge the surface waters which fall upon them, *on every side,* through valleys, to the common level of the deep.



General forms of Continents.

The object of thus drawing the attention of the reader to those superficial features of the dry land,

very lively picture of the outlines of the country between the basin of the Mississippi, and that of the Columbia; and of the narrow ridge of the Rocky Mountains, which there separates the immense prairies of North America. It appears, by a note at the end of that work, that the ridge of the Rocky Mountains presents some points, which may compete, in point of elevation, even with the most lofty of the Himalayas. They are computed at from twenty to twenty-five thousand feet of height. Some of them are supposed to exhibit volcanic craters, though not now in activity.

may not now, perhaps, be readily apparent to all; but it will ultimately be found to be of the utmost importance to the elucidation of the subject of this Treatise; and the above facts, which every where display such uniformity of character throughout the world, ought therefore to be deeply impressed upon the mind, and to be still further strengthened by a direct reference to *nature*, in all places with which we are well acquainted; or to such maps of the more remote countries, as exhibit a correct outline of the rivers, by the currents of which, alone, we can form a just conception of the extent of plains, and of the general inclinations of a country.

Having thus rapidly glanced at the prevailing superficial features of the existing dry lands, it becomes necessary that we should, in like manner, take a general survey of what is known, of their interior mineral structure. It is not at present my intention, however, to do more than give a very brief and general outline of so intricate a subject; but such outline, slight as it may be, is necessary, in order fully to comprehend the facts with regard to *valleys*, to which we shall next have to turn our attention. On this subject, there are but few readers who are now entirely ignorant of the geological facts so fully described in the numerous publications of the day, by which facts we learn, that the surface of our globe, as far as man has been enabled to *scratch* into it, (for he has not yet done more, nor is it probable that he ever will,) is composed of a variety of layers or strata of rock, possessing, individually, various mineral characters, and reposing one upon another, in every degree of inclination, from horizontal to vertical. The study of these, with their rich mineral and fossil contents, has grown, within our own time, into one of the most interesting and important branches of scientific research; and is only second to astronomy in the views it opens, of the wonderful power and goodness of the Creator of the universe. In some respects, indeed, geology seems calculated more powerfully to rivet the attention of the general observer, than even astronomy itself, with all its wonders. For as, in some splendid work of painting or of architecture, we pass from the admiration of the whole, to the delight of studying the first sketches and ideas of the artist, by means of which we are enabled to trace, as it were, the steps by which his genius worked, and the gradations of thought, by which the whole composition was, at length, perfected; so, if we may be permitted, for a moment, to compare great things to small, we pass from the view of the astronomical *whole*, to the more minute study of the geological *parts:* and thus endeavour to form some conception, though it may be but obscure, of the mode of operation, by which our planet has been made to assume its present superficial forms. Beyond the *mere surface*, however, we never can hope to attain, though the daring genius of man is tempted onwards, to theorize upon the hidden regions of our "dark terrestrial ball." The very dimness of our prospects, only serves the more to excite our curiosity and speculation; but although the facts of geology come more directly within the reach of our sight and touch, than those of astronomy, yet we can entertain no reasonable hope of the whole, as a science, being ever brought within such strictly mathematical laws of demonstration, as have been so wonderfully applied by human genius, to the more remote, and often invisible phenomena of the sister science. The very nearness of the facts, may often add to the difficulty of justly generalizing with regard to them; for we find ourselves so placed as to be enabled to examine, as it were microscopically, the texture of the canvass, while we can only mentally withdraw ourselves to the proper distance, for viewing, with full effect, the whole subject represented upon it.

The united labours of geologists, in every quarter of the globe, have, however, established some facts, which, in a general view, will no longer admit of doubt, though in the classification of some of the minutiæ, changes of importance may possibly yet be effected. The surface of the dry lands of the earth, has thus been found to be composed of such strata as have been already mentioned, to what appears to be a very considerable depth, when measured by our minute standard of *feet* and *inches*; but which becomes reduced to almost nothing, when the real scale of *miles*, by which we compute the diameter of the Earth, is applied to them. This diameter amounts to nearly *eight thousand miles,* or to about forty-two millions, two hundred and forty thousand *feet;* whereas we have no human means of attaining a real depth of much more than about *a quarter of a mile,* the deepest mines being little more than about one thousand five hundred feet, their general object being to search either for coal, or for the precious metals, which lie near the lower parts of the above-mentioned series of strata. Though this, however, is the *fact,* we may, in *theory,* calculate upon a much greater depth of such secondary strata, if we suppose a case, (which is not, however, any where *known* to exist,) of all the sedimentary strata, in their greatest thickness, being piled one upon another in any one spot. In such a case, we have sufficient evidence to be persuaded, that the stratified rocks would measure many thousand *feet* in thickness. But even in such a case, wherein we should finally reach the lowest rock with which we are acquainted, and on which all stratified rocks are supposed to be based, we are there left in almost utter darkness, and can form no analogy between the structure of the few miles of which we thus have knowledge, and the vast intermediate diameter, or central space, of nearly eight thousand miles, which constitute the solid diameter of the globe. "It has sometimes been maintained by fanciful theorists," says an able writer, "that the earth is merely a *shell,* and that its central parts are *hollow.* All the reasons we can collect, appear to be in favour of its being *a solid mass*, considerably denser than any known rock." "We see, therefore," (by the universally felt effects of the laws of gravity,) "that those dark and unknown central portions of the earth, which are placed far beyond the reach of the miner and the geologist, and of which man will probably never know any thing directly, are not to be considered as quite disconnected with us, as deposits of useless lumber, without effect or purpose. We feel their influence on every step we take, and in every breath we draw; and the powers we possess, and the comforts we enjoy, would be unprofitable to us, if they had not been prepared with a reference to those, as well as to the near and visible portions of the earth's mass*."

The examination of the mineral matter ejected by active volcanoes, constitutes the only direct evidence on which we can hope to form the smallest judgment, as to the nature of the deeper seated regions of our planet. But so contradictory has the evidence of this nature been hitherto found, that while some philosophers consider those volcanic foci to be extremely deep seated, others have, with much shew of reason, regarded their action as exhibiting proofs of but trifling depth; and have been disposed to limit the seat of what appears to man so frightful, and what has, in fact, often proved to him so destructive, to the mere regions of the superficial deposits, and, consequently, to a depth but slightly removed from the general surface of the earth.

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* *Whewell's Bridgewater Treatise*, p. 50.

The general theory of the earth, which has lately been laid before the world, in one of the Bridgewater Treatises, is thus described. The author had previously stated, that the mere "*crust* of the globe, *floated on an internal nucleus of molten elements*," which elements burst forth from time to time, in liquid streams of lava*; and he recapitulates his theory, in the end of his work, in the following words: "In an early part of our inquiry, we traced back the history of the primary rocks, which composed the first solid materials of the globe, to a probable condition of *universal fusion*, incompatible with the existence of any forms of organic life; and saw reason to conclude, that as the crust of the globe became *gradually* reduced in temperature, the unstratified crystalline rocks, and the stratified rocks produced by their destruction, were disposed and modified, during long periods of time, *by physical forces, the same in kind with those which actually subsist*, but more intense in their degree of operation; and that the result has been, to adapt our planet to become the receptacle of divers races of vegetable and animal beings, and finally to render it a fit and convenient habitation for man."—p. 581. A somewhat similar theory was formerly proposed by Buffon, who, however, proceeded a step higher, in the history of the originally fused mass, and accounted for its detached position in the system, by supposing it to be a small portion of the sun, broken off by the stroke of some eccentric comet. Both theories seem to be open to the serious imputation of setting aside, in a great degree, Creative Power and Wisdom, and of attributing to *second causes*, the beautiful arrangements of our earth; for it seems entirely unworthy of the attributes of the Almighty, (to say nothing of its being directly opposed to the simple reading of Revelation,) to imagine a necessity for His waiting, " during long periods of time," for the " modification of the crystalline rocks, by such physical forces as now actually exist," by which modifications, (that is, of meteoric action, as winds, rains, river-floods, &c.) the cooling mass was at length to become adapted to the reception of divers races of animals, and finally to become fitted, after an immense lapse of ages, for the convenient habitation of man.

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* *Bridgewater Treatise on Geology*, p. 47.

The mineral formations of which we are now to give a short and general outline, have been divided by geologists into four different classes, termed *primary*, *transition*, *secondary*, and *tertiary*. Other terms have been proposed by the latest writers, as being more comprehensive, such as *hypogene*, or *nether-formed* rocks, (that is, formed *beneath* the surface,) instead of primary; and *metamorphic*, (or *changed*,) as applicable to some of the primary and transition rocks, in the idea that many of them may be, in fact, secondary formations, but changed by the effects of heat, and their fossils thus obliterated. To the tertiary rocks, or the more recent deposits, new terms have also been given, having reference to the numerical proportions which their fossils bear to existing species. Thus, in descending order, from the general diluvial covering, we have the newer Pliocene, the older Pliocene, the Miocene, and the Eocene groups, reposing on the chalk, which is the highest of the *secondary* rocks. The young geological student, on seeing the long list of distinct strata of which these classes are composed, and on examining the beautiful theoretic sections, by which the series is generally illustrated, would be led to conclude that there were, between each, distinct indications of certain pauses, or cessations from the action of deposition, during which pauses, long periods may have occurred, and changes of creation may have been effected, in the organic world. Nothing can, however, be more erroneous than he would find such ideas to be, on comparing the *sharp* outlines of these highly coloured sections, with the *undefined* outlines of all these rocks, when examined, in nature, at the actual point of contact, where he will find one formation gliding into another, with so obvious a *transition*, and such clear proofs of *both* having been deposited in a moist state, *without any material pause*, that his preconceived notions *as to the immensity of time*, must be greatly modified; and he will in vain look for indications of former habitable surfaces, similar to that which at present exists. Nor are these easy *transitions* confined to only a few of the secondary rocks. *From granite upwards,* even to the very surface of the present dry lands, he will find these evidences, as I shall take a subsequent opportunity of more fully explaining, in a future chapter.

The following list of formations, in descending order, comprises the leading members of the whole series of rocks, without reference to the more minute subdivisions, in which they have been classed by geologists.

1st. Recent formations, as peat, silt, and sand, &c., in lakes, and estuaries.

2nd. Diluvium, or strata of gravel, clay, sand, loam, &c., which indiscriminately overspread *the whole* of the following rocks, wherever they come to the surface.

Tertiary.	3rd. Newer Pliocene. 4th. Older do. 5th. Miocene. 6th. Eocene.	Hampshire, Paris, London, and other basins. Fossils of a mixed nature, marine, terrestrial, and fresh-water.
Secondary.	7th. Chalk,	marine fossils.
	8th. Gault and Greensand,	do. do.
	9th. Wealden strata,	mixed terrestrial and marine fossils.
	10th. Oolite, or Jurastic limestones,	marine fossils.
	11th. Lias,	marine and terrestrial fossils.
	12th. Keuper, sand-stones.	
	13th. Muschel kalk,	marine fossils.
	14th. Variegated sand-stones.	
	15th. Magnesian limestone,	marine fossils.
	16th. Coal measures,	mixed fossils, marine, terrestrial, and fresh-water.
	17th. Mountain limestone,	marine fossils.
	18th. Old red sand-stone.	

Transition.	19th.	Grauwacke, consisting of conglomerates, shales, &c.,	marine.
	20th.	Schistoze rocks.	
Primary.	21st.	Gneiss, and Granitic rocks.	

Of these rocks, all, except the last, are admitted to be the result of sedimentary deposits, *in water;* and they are all, consequently, more or less, distinctly *stratified;* water being the only medium in which this beautiful and most beneficial arrangement can possibly occur. The primary rocks have long been regarded as of *igneous* or volcanic origin, though the discoveries of every year, tend to confirm the objections which have, from time to time, been advanced, against this part of the Huttonian theory.

As has been already remarked, the most instructive points in this series, with regard to the *mode*, and the *periods*, of the deposition of the different members of it, are, the immediate points of *contact*, or the line where any two of them meet. This is found, on studying the subject from *nature*, to be, in general, so indefinite, as to show that the inferior mass was yet soft, and in the condition of sand or mud, when the superior sediments were deposited upon it; and we may, therefore, infer, that the various *chemical* changes, by crystallization, or otherwise, by which rocks are now distinguished from one another, have occurred subsequently, so as to convert what was once *soft*, into the indurated and useful solids, on which mankind so much depend, for economical purposes.

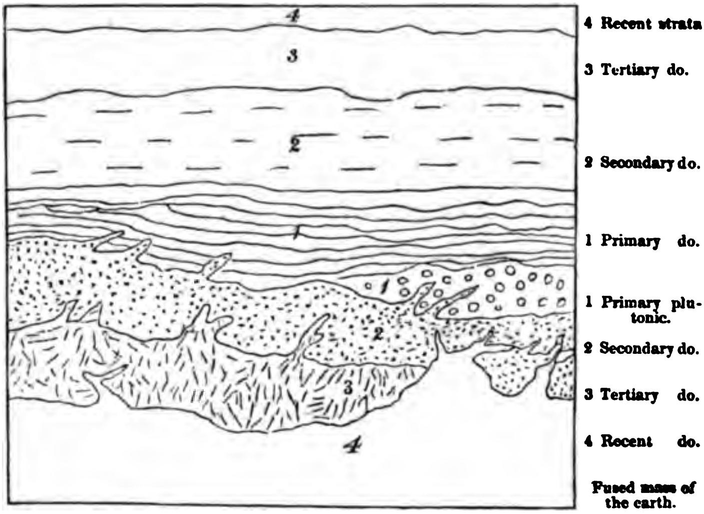
In the case of the general *diluvial* beds, which repose indiscriminately upon *all rocks*, as they chance to occur upon the surface, the facts are so distinctly different, as at once to indicate an equal difference in the *mode* by which they were placed where we now find them. Few persons are, perhaps, aware of the vast importance to mankind, of this diluvial covering, and of the evidence of *design*, which it so plainly exhibits to the reflective mind. It is, almost exclusively by means of it, that the richest and most beautiful lowland districts have acquired their fertility and beauty. Even in hilly districts, the *smoothness* and *rotundity* which generally characterize the surface, have, in a great degree, arisen from all the fractures and inequalities of the solid rocks, having been filled up with this matter, and the whole having been finally smoothed off, by the action of water. This is at once evident, on considering the rugged surface of the solid rocks, where the diluvial soils have been removed, for the purposes of quarrying; and we there discover in what a state of hideous and barren waste, the surface of the present lands would have been left by the Deluge, but for this wise and beneficial result, from an awful and destructive catastrophe. Thus, as fertility is cherished by the corruption of decayed vegetable and animal bodies, so, under the wise guidance of the Almighty Architect of the universe, the greatest possible good has been made to result from the greatest of known calamities; and effects which are too frequently attributed to mere *second causes*, or to *chance*, may thus be clearly traced to the benevolent designs of the Creator.

Such, then, is the general order in which the strata of the earth's surface succeed each other; and as by far the greater number of these strata bear unequivocal marks of their *marine* origin, while many of those attributed to *fresh-water* are found to be of a mixed and doubtful character, we must conclude that each stratum formed, alternately, *a sub-aqueous surface*, and that the organic remains which they now exhibit, were embedded in soft sedimentary matter, however changed and indurated this originally soft matrix may have subsequently become, by the chymical processes of nature.

It is a prevailing opinion in Geology, that by some internal *expansive* power, the real nature of which has never been explained, but which is usually termed *volcanic*, the lower masses of *unstratified* rocks, called primary, have been, *from time to time*, elevated, and protruded in a fluid state, through the stratified deposits, at periods long subsequent to their deposition; and that the horizontality of these latter has been thus disturbed, and their beds placed in inclined positions, at various angles with the horizon.

It is a self-evident fact that the secondary strata have been so elevated; as almost every section, and especially of the lower portions of the series, exhibits strata, which must have been deposited horizontally, or nearly so, thus inclined; but the causes of such elevation, and still more, the *often repeated* recurrence of such disturbing forces, whatever these may have been, are points which still remain somewhat problematical. We shall have occasion, throughout the whole of this treatise, to adduce evidence of one vast instance of disturbing force, sufficient, of itself, to account for the greater part, if not all, of the inclinations from the horizontal, which the secondary rocks exhibit; but there is also strong evidence of some former disturbances, on a minor scale, and probably *submarine*, at earlier geological periods, by which some rocks have been partially elevated, and sediments have been subsequently deposited, *unconformably*, upon them. There is no reason from the evidences, however, for supposing that such former disturbing causes were in any degree comparable with that of which we now have demonstrative proof, as having occurred at a very recent period: and as it must yet require much time and study, to arrive at any just idea of the real extent to which this latter disturbance acted, it is unnecessary to theorise on *uncertain* events, until we have fathomed the full extent of the *real* event, which, it must be admitted, claims precedence of every other, in the order of geological chronology; and to the neglect of which, we may probably trace much of the obscurity which has hitherto overshadowed this interesting branch of science.

The author of the *Principles of Geology* conceives, that the primary rocks are the more ***recent, the deeper we go;*** and that the sedimentary strata are, on the contrary, the more recent, ***the higher we go.*** In other words, that fresh granites are constantly *cooling* below the older crust, which is thus becoming constantly thicker, as it rests upon ***the internal ball of fused matter;*** while, at the same time, the older crystallizations of these rocks are being gradually and slowly upheaved, by some indescribable expansive force. This singular theory is illustrated by the following diagram :



Thus, he supposes with the Huttonians, that a constant interchange is in progress between sea and land, though by slow, and, to us, almost insensible degrees, instead of by the more violent paroxysms, which Hutton and his followers advocated.

Now, if we suppose, for a moment, this theory to be correct, and trace it up to the *commencement* of things, we must proceed *downwards* from the present surface, and *upwards* from the supposed melted mass of fused matter still within, until we reach the period when *the first aqueous sediments* were deposited, *upon the first thin crust of indurated granite,* still, of course, possessing a high degree of heat, from its immediate contact with the primitive fluid globe below. At this point, then, our difficulties commence: for, in the first place, where was the element of *water*, during the first stages of the fused globe; and, supposing it to be found, how could it escape *evaporation*, instead of depositing sediments, on the heated granitic crust? How could rivers exist, without lands of varied forms, and *cold* mountains on which to condense the vapours? and where did these sediments come from, in the absence of *rivers?* We are led, in short, to a point of most repulsive contact, between the opposing elements of *fire* and *water;* and in this state of inextricable confusion, we are content to leave this theory, without attempting to fill up that blank which its author has left, with regard to the *first movements* of this unnatural mechanism. As it is, however, almost universal with geologists, to treat of granite and the primary rocks, as if they were indisputably crystallized from a state of *fusion,* I shall take this opportunity of stating the reasons why I, for one, cannot subscribe to this favourite idea; and shall point out some objections to it, which appear to me to possess all the force of mathematical demonstration. In the first place, then, granite is not unfrequently found so intimately intermingled, and even in some degree *interstratified* at the point of contact, with some stratified rocks, which are properly attributed to the action of *water,* that the idea of *aqueous* fluidity, rather than *igneous,* at once presents itself to the mind. Thus, not to mention the *insensible* transitions from granite to the stratified rocks, which have lately attracted so much attention, as occurring in the mountains of the Vosges, in France, and described so clearly by M. Rozet*; and the equally insensible changes of a similar kind, to be seen in Cornwall, as noticed by Dr. Boase† and others, we may at once refer to those conclusive facts which have long attracted the attention of philosophers, in Glen Tilt, in Perthshire, where granite is seen so completely intermingled with regularly stratified limestone, at the point of contact, that no candid mind can, for a moment, hesitate in attributing both formations to *one* or *other* of these agencies, but certainly not *to both.* Nor is this intermixture confined merely to the *veins* of granite in the limestone, from which Hutton raised so powerful an argument in support of his theory, while the more *gradual* intermixtures were passed over without notice. I have now before me a very complete series of specimens from many parts of Glen Tilt, illustrative of this subject; in many of which, not only are the red veins beautifully displayed in the blue limestone, but entire crystals of the constituents of the granite, are seen *detached* in the hardened sedimentary *pâte* of the limestone, and in so entire and regular a form, as to leave no doubt that they were *there* crystallized, and that the mixture of the two must have taken place *in a cool state*, and not in a state *of fusion in the one case, and of aqueous sediment in the other.* This fact is also strongly recalled to the mind, on examining the points of contact, between the rock-salt deposits in Cheshire, and the hardened, sedimentary rock, with which they are associated. I have now, also, before me, specimens of these rocks, in which the cubes of salt, of various sizes, are seen completely *isolated*, like those of the felspar, in the limestone of Glen Tilt, and which have *pushed aside*, as it were, the earthy particles, thus plainly implying a state of *mutual and contemporaneous fluidity.* The two cases seem completely analogous, except that no one has ever doubted that both the salt, and its associated rocks, were once fluid *in water;* whereas theory has long attributed to granite a primitive fluidity, from a state of *fusion*. It remains for geologists to show how *fire* and *water* could combine their influences in so friendly a manner as they must have done in the case of Glen Tilt, if the above theory is to be adopted*.

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* *Description Géologique de la Région Ancienne de la Chaine des Vosges.*—(Paris, 1834.)

† *Treatise on Primary Geology.*—(1835.)

The second objection to this theory of the originally *fused* state of granite, is of a still more powerful nature, at once denying to this rock an *igneous* fluidity, and with as conclusive force as the solution of any mathematical problem. According to the theory of Hutton, almost all rocks were supposed to have been acted upon by an intense heat, which was said to exist in the central regions of the globe, and many of them, to have once been in a state of actual *fusion*. Werner, on the contrary, held, that all rocks had been either crystallized, or deposited, or both, from *aqueous* fluidity. While, with regard to the greater proportion of rocks, the Huttonian has now ceded to the Wernerian theory, the ideas of the former still hold their ground, with respect to granite, and the other unstratified rocks. They are still looked upon by most geologists, as having been crystallized from a state of *fusion*; for no one can doubt, if we may be allowed to draw inferences from such crystallizations as take place before our eyes, that this, like every other crystallized rock, or substance, was once *in a fluid state.*

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* The phenomena of Glen Tilt have obtained celebrity from many combined causes; but there are other situations in Scotland where similar facts are still more striking, though extended over a wider space, and, therefore, not so conveniently studied. In the space between Stonehaven and Aberdeen, along the sea-coast, where the sections in the cliffs are accessible, though not without some fatigue, the *insensible transitions from the stratified red sand, through the schist rocks, to pure granite*, are facts which will amply repay the attention bestowed upon them. I shall have a subsequent opportunity of describing these facts, when treating of the cliffs of that coast.

Granite is composed of three simple minerals, *viz.*, quartz, felspar, and mica; and the predominance, more or less, of these, gives rise to endless varieties in the appearance of the rock, in different localities. All these three minerals exhibit crystals of perfectly different forms. The quartz crystal is best known, from its being most commonly found in a perfect form; that of felspar, in a perfect state, is much less frequently seen; while complete crystals of mica, are so rare, that I have myself seldom seen them, except from one locality, from which I have obtained several beautiful specimens. When we break a solid mass of granite, or of any other crystallized substance, we can generally form but a faint idea of the shape of its crystals when entire. It is only when *cavities* occur in a rock, that the crystals have had space to shoot into their fully developed forms; and as such cavities are not of frequent occurrence in granite, it is rare to obtain specimens, in which all the constituent minerals have *intermingled* their fully formed crystals. The locality just alluded to, as presenting the most instructive specimens of granite crystals that I have ever seen, occurs in a part of the hill of Benachie, in Aberdeenshire. We there find a very small grained granite, in which are numerous cavities; and in these, the three constituent minerals are found in the most beautiful perfection, the felspar being sometimes seen in crystals of two inches square; and the whole being so intimately mingled, and *interlocked*, one within the other, as plainly to show that they were all *simultaneously* formed.

Now, it has been shown by that eminent chymist, the late Dr. John Murray, of Edinburgh, that these constituents of granite are *fusible*, only at widely different degrees of heat. Thus, felspar was found to melt the most easily, and at a heat of only 120° or 130° of Wedgewood's scale. Quartz, on the contrary, is scarcely fusible at all, and does not yield, except under a heat of *upwards of* 4,000° *of the same scale**. Mica is not taken into the account by Dr. Murray, as the argument did not require it; but it is probably an almost infusible substance. In the numerous specimens from Benachie, now before me, we find the most beautiful groups of all the three substances, fully developed, *and intermingled with each other;* and they must naturally have assumed these forms, *at the very moment when the granitic mass, of which the whole hill consists, became indurated, from a fluid state.* But how shall we account for these forms, so closely associated, and interlocked, by supposing that the mass to which they belong, was once in a fluid state from *fusion?* We have no grounds for supposing that heat would have produced a different effect upon these separate minerals *formerly,* from what it does *now.* How then, could they all crystallize *at the same time?* Is it not self-evident that when the quartz, (which cannot now be melted under a heat of 4,000°,) had cooled down to within 120° or 130° of its present cold solidity, the felspar would have still been in a fluid state, by contact even with this low degree of heat; and yet I have now before me, specimens of perfect felspar crystals, of more than an inch square, completely bedewed with small crystals of quartz, which have shot *through the felspar,* and have instantly assumed their usual prismatic forms *on its surface,* as soon as they found sufficient space and freedom so to do. As well might we suppose that in the case of a mixture of melted *gold,* of *lead,* and of *wax,* the wax should *first* become cold, then the lead, and last of all, the gold!

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* See '*A comparative view of the Huttonian and Wernerian systems of Geology.*' Anonymous, but written by Dr. Murray. Edinburgh 1802.

We arrive at the very same conclusion, from an examination of those beautiful specimens of native gold, silver, lead, and other metals, in their crystallized forms, in a matrix of quartz rock, which may be seen in most cabinets of mineralogy. We know that all these metals are fusible at no very great degree of heat; we also know that the rock which contains them is scarcely fusible at all: and yet we see the metals shooting through the rock, and *both the one and the other forming its respective crystals, in the closest contact.* How then can we consistently argue that both have cooled *simultaneously, from a state of fusion?* At this point of our argument we cannot but be powerfully struck with the facts which have lately created so great a sensation in the geological world, and which were so unexpectedly announced at the late scientific meeting at Bristol, (1836). I allude to the discovery of Mr. Cross, by which he has been enabled to obtain *artificial* crystals of many different minerals, and amongst the rest, of *quartz, not from fusion,* but by the continued effects of galvanic action, *on water.* This gentleman stated that the process was found to be more rapid in *darkness* than in *light;* and that he saw no reason to doubt the possibility of obtaining, in due time, every variety of *artificial mineral, by electric agency alone,* the diamond itself not excepted! When, to all this, we add the fact which has long been remarked in mining districts, that mineral veins have generally a direction such as electricity might have occasioned, or at least have materially influenced, it appears as if an entirely new light was about to break in upon us, on the subject of crystallization in general; but in which the Huttonian idea of *intense heat*, will probably find no place. No volcano has ever been known to eject fluid *granite;* nor are we acquainted with any well authenticated instance of the *upheaving* of granite on a great scale, within the historic periods. As granite, then, is the deepest mineral on which we can reason; and as volcanoes, small as their depth may be, are the deepest known channels through which we can obtain any knowledge, or idea, of the interior of the earth, we are not justified in reasoning on either a *former*, or an *existing* fluidity from *heat*, in the mass of our planet, or in supposing our now solid surface to be but a thin *crust* floating like ice, upon a fluid sphere*. Much stress is generally laid on the fact of *hot springs*, as being indicative of a generally heated interior. But if a hot spring is to be taken as a proof of heat in the locality from whence it rises, we may surely, on the like grounds, argue that *cold springs* in like manner attest the *absence* of heat, in the places from whence they come. Now, as we see *thousands* of cold springs, for *one* hot one, there seems to be a vast preponderance of such evidence against interior heat, if water, rising from that interior, is to be taken as a proof. We know from chymistry that heat can be generated by the combination of two *cold* substances; and that cold water in contact with some minerals, will occasion combustion. We have, at this moment, in England, an instance of this fact, in a burning cliff, occasioned solely by a wet season, and in the entire absence of every volcanic symptom*. In the study of volcanoes, we find many clear evidences of water being often present, in the seat of the interior combustion. Such water, combined with salt, is often ejected from craters; and such marine evidences, together with the immediate neighbourhood of the sea, so general in active volcanoes, form strong ground for supposing that to such chemical agency alone, may possibly be due the singular phenomena of these terrific fires; without any necessity for supposing them of more than trifling depth, compared with the scale of the globe itself. In this view of the subject, the known powers of vapour, such as must naturally arise from heated water, would sufficiently account for all the phenomena of earthquakes, the shocks of which are sometimes felt to vibrate so extensively, through the superficial strata of the earth. In an interesting paper by Sir H. Davy, in the Transactions of the Royal Society (1828), on the subject of volcanoes, and especially describing an eruption of Vesuvius, he says, that on holding a tin funnel, filled with cold water, in the white fumes proceeding from the flowing lava, it became coated with a white powder, which proved to be *common salt*, absolutely pure; and that among various sublimations which he found covering the rocks of ancient lava, through a cavity of which, the melted matter was flowing, he observed crystals of common salt, *in great excess*, thus indicating the presence of *sea water* in the crater, reduced by heat to vapour, and depositing its saline matter, as in a common salt pan. "Wherever the crater could be approached," says Sir Humphrey, "it was found incrusted with saline incrustations; and the walk to the edge of the small crater, was through a mass of loose saline matter, principally common salt, coloured by muriate of iron, in which the foot sunk to some depth."

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* We have, in the instance of the above-described facts respecting the component parts of granite, a complete proof of the slow progress by which Geology can ever hope to become classed with Astronomy, or the other experimental branches of the Sciences. The work of Dr. Murray, to which I have referred, was written during the heat of the Huttonian and Wernerian controversy, and was acknowledged at the time, (1802,) to contain the most powerful demonstration, inimical to Hutton's theory. Playfair, in reply to whose '*Illustrations of the Huttonian Theory*' this anonymous work was written, was unable to refute the arguments, the force and beauty of which, he candidly admitted. But Geology was not the profession of its Author. He ceased to write upon it; the volume was never reprinted, and is now seldom met with.

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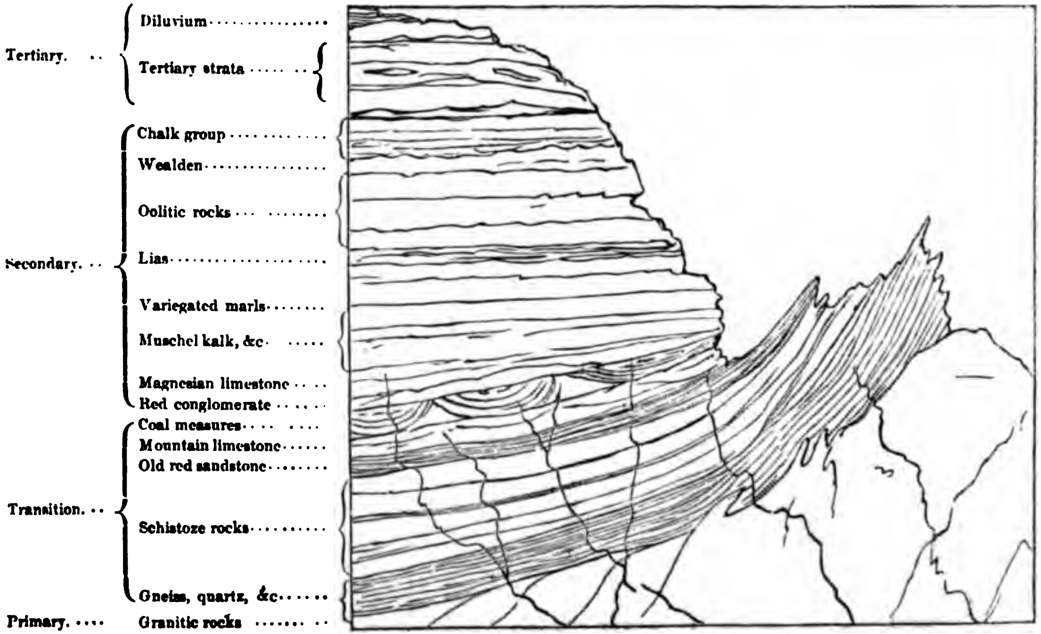
* Extract of a letter from a passenger on board the *London*, dated Calcutta, October 31:—"Had we been kept out at sea but a few days longer, we should have been burnt: the coals, (our dead weight,) got wet in the gale, heated, and ignited; and on the day of our arrival here, on opening the hold, smoke issued forth. The cargo was discharged with all haste, and about one hundred natives aided the crew to bail in water, and then discharge the coals. For four days the ship was in jeopardy, and twice they came to *a body of red-hot coals*, in two parts of the hold, which blazed up on being opened, and was only got the better of, by pumping two or three feet of water into the ship."

On a later occasion, the Captain and several officers of the Sabrina sloop of war, landed on the new volcanic island in the Mediterranean, which was then between two and three hundred feet high, and about a mile in circumference. In the middle of the crater was a large basin of *boiling water*, from whence a stream, six yards wide, ran over into the sea. This water, so much above the level of the sea, must have sprung from the bottom of the crater, communicating with the lower depths; and it thus appears certain, that the water of the sea had some share in producing this convulsion. In 1794, torrents of *mud* and *salt-water* were poured from Vesuvius; and Humboldt states, that many of the volcanoes of South America throw out mud, and, in some instances, quantities of *fish* with the water.

But we must now return to the consideration of the present state of the mineral beds which compose the surface of the earth, as far as they are open to our inspection. The annexed sketch may serve to show the general position of the various rocks, as they are represented theoretically, by M. Alexander Broignart, and will give as good a general idea of their relative positions in the series, as can be expected from mere theory.


Tertiary.
Diluvium
Tertiary strata
Secondary.
Chalk group
Wealden
Oolitic rocks
Lias
Variegated marls
Muschel kalk, &c.
Magnesian limestone
Red conglomerate
Transition.
Coal measures
Mountain limestone
Old red sandstone
Schistoze rocks
Gneiss, quartz, &c.
Primary.
Granitic rocks

From this sketch it appears, that some of the most lofty pinnacles in the mountain ridges of the world, consist of the early stratified rocks, as gneiss, and the schistoze formations; while the deeper-seated granite, which forms the base of the whole, is often less elevated, and generally presents a more smooth and *rounded* outline. As we rise in the series of sedimentary rocks, we find the strata disposed more and more horizontally, or, in other words, less disturbed; until, on reaching the central, and upper deposits, the deviations from horizontality are more rare, when viewed on a large scale, although, in smaller spaces, we constantly find more or less of inclination. There are, however, some very remarkable exceptions to this common rule; as, for instance, in the Isle of Wight, and in the corresponding parts of England, where the chalk, and its neighbouring formations, which are usually almost horizontal, are seen in a position completely *vertical;* and that without any such visible *cause,* as the immediate vicinity of primary or volcanic rocks.

But we must not be so far misled by such theoretical views, as to imagine that on every part of the earth, the regularity of this series is always to be found. As has already been remarked, the chasms, and deficiencies are so frequent, that we cannot calculate with any certainty, on what may be actually beneath our feet. These are difficulties and anomalies which still remain obscure; nor can we possibly account for the *universality* of the phenomena of some of the old strata, on the one hand, or, the total absence of some strata on the other, by any of the laws of *mixed* deposition, which we now see in slow progress, on the earth. But by whatever means these strata became disturbed, whether at one period, or by repeated movements, of one thing we are well assured, which is, that no conceivable arrangement could be more conducive to *human wants*, and consequently more indicative of beneficent Design, than that which is, in reality, found to exist. Without some such contrivance, the deeper seated of the rocks, which are also richest in mineral productions, (such as the precious metals, together with coal, iron, &c.) must have been so overlaid by the higher deposits, as to have been for ever buried, far beyond the reach of man. Even in their present elevated condition, their precious contents would have been infinitely more difficult of access, had the surface of the earth been of a plain and equal outline. It is, therefore, by the beautiful contrivance of *valleys*, that a much more ready access to them is obtained. These valleys, as I hope to be enabled to prove, could only have arisen from powerful *aqueous* action. We shall subsequently find the clearest evidences not only of this, but of that action having been *universal*, and at a very recent period. We are, therefore, naturally led to infer, that *the whole Design* of the Great Designer, both as to the *elevation* of the beds, and the more ready access to them by deep valleys, was brought into effect, *by one and the same event*; and that as all valleys can be demonstrably traced to a *recent* origin, the three grand effects resulting from them, *viz.* 1st, *drainage;* 2nd, *a more ready access to the interior; and* 3rd, *a greater extent of surface, for the more abundant support of animal life*, must have been contemplated, in that great decree by which they were called into being. It is in vain, however, to theorise upon the *mode* by which such Designs were brought about. It may be quite natural, and it is even highly becoming in man, to scrutinize the effects which have been produced from them: there is a line, however, beyond which our reason cannot guide us; and instead of vainly attempting to overleap this boundary, we shall be better employed in carefully working our way *up to it*, by conclusive reasoning, and then humbly confessing that we can advance no further. With this object in view, then, I shall now conclude these preliminary observations, and proceed to the consideration of phenomena of the most interesting and instructive character; and which exhibit evidences within the more ready apprehension even of the least scientific readers.

CHAPTER III.

ON THE CEASELESS FLOW OF RIVERS, AND ON THE SYSTEMS AND GROUPS OF VALLEYS, BY MEANS OF WHICH THE DRAINAGE OF THE DRY LANDS IS EFFECTED.

Of the natural evidences in proof of the recent *commencement* of the existing state of things upon the earth, the first to which I shall request the attention of the reader, arises from the *ceaseless* action of flowing waters, which we contemplate in every river. It has long been the object of human study to discover in nature, and to apply to mechanics, *a perpetual motion.* Much time and ingenuity, both in reasoning and in mechanism, has already been wasted upon this vain subject of research. It is clear, that in mechanics, the desired object never can be attained, from the very simple cause of the destructibility of even the hardest materials, by long continued friction ; and no means have yet been, or are likely to be, discovered, of obviating this difficulty. In nature alone can we discover this great *desideratum ;* but when we attempt to extend it to works of art, the perishing nature even of our best materials, soon leads to the conviction that the attempt is vain. But even in the works of nature we have no great variety in perpetual motion. *Water* and *air* are amongst the only active agents that never cease, nor ever can cease, to be in motion; the former by the *tides* and *currents*, dependent on the movements of the planet, and the attractive powers of the sun and moon; the latter, by a combination of the like movements, and the varieties of atmospheric temperature. To the movements of air, we owe the wind-mill; to those of water, the water-mill; but neither can lay claim to the attribute of perpetual motion. Although, in the case of water, this ceaseless movement belongs, strictly speaking, to the ocean alone, and would there continue even if the sphere were entirely enveloped in a watery covering*, yet we find a degree of motion which almost merits the name of *perpetual*, even in a river. There is, however, this difference; that while the movements of the ocean are quite independent of the land, those of the river could not exist without it; when, as in the case of the wind or water-mill, if the *materials* fail, or are worn away by friction, the movement must instantly cease, and the character of *perpetual* disappear. It may, indeed, be truly said, that the materials on which the river acts, are more durable than those of which the mill is constructed. This, however, is only comparatively speaking; and there cannot be much difficulty in supposing, or even in discovering, a case, on a small scale, in which, *if we*

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* See a paper, by the author, "*On the Currents of the Ocean*," in the *United Service Journal* for December 1833.

allow sufficient time, the friction of flowing water would wear away all opposition: the materials would fail; and the motion would ultimately cease, for want of an *inclined* plane on which to act. This, however, though it may be correct reasoning, in point of theory, can seldom, if ever, be applied to practice. For all the *finite* reasoning purposes of finite man, the flowing river may be regarded as equally *perpetual* in its movements, with the restless ocean; and the two may be brought to bear with equal force, in their respective stations, upon the subject of our present inquiry.

If the mechanic construct a machine, (such, for instance, as the saw-mill,) which shall be regular in its movements, and make a certain number of revolutions, or strokes, *per second* or *per minute*, and if he become aware of the amount of action produced by each revolution, or stroke, he has no difficulty in computing before hand, and with the utmost exactness, the time that will be necessary for the performance of any proposed work. He knows, however, that from the particular construction of the mechanism, the movement could not take place in the absence of some particular wheel; the instant that wheel is added, however, and the *primum mobile* is applied, (as water in the case of the saw-mill,) from that moment the regularity of the strokes will commence, and the movement will be *ceaseless*, as long as the *primum mobile* remains in force, and the materials of the mechanism retain their strength and form.

If such is the case in the artificial productions of human genius, it is not less so in the great scale of natural mechanism. The valleys, or inclined planes of the dry lands, *sloping, on all sides, to the exact level of the ocean,* are the parts of the great machine prepared, before hand, by the Divine Mechanic. The condensations of the aqueous vapours, with which the atmosphere is, at all times, charged, may be compared to that important wheel, which it was alone necessary to contrive, in order to give to the whole, a regular and a ceaseless movement. That wheel was contrived and added, *on the very first day that the dry lands over-topped the level of their native waters.* The springs, the brooks, the rivers, gradually combining their united forces, were then, *for the first time,* set in motion, governed by that great law of fluids, by which they are compelled to seek their common level in the deep: and *from that day to the present hour,* the movement, thus begun, has been regular and ceaseless: the friction of the parts of this vast hydraulic machine, has, however, been not less incessant; and all that is now required to enable us to compute the period of this mechanic action, is the knowledge of the amount of work done at any well defined spot, in a given period of time, the original size and form of the materials at that spot, being previously ascertained.

Before we enter, however, upon the examination of any such index as may point out the amount of work thus already executed, and the *period* occupied in the completion of that work, it will be proper that we dedicate a few moments to the inspection and admiration of the machine itself, to which I have just alluded; a contrivance so simple, so beautiful, and yet, in its construction, so much beyond any of the powers of nature which we now see in action, that we must attribute it, like the channels in the animal body, to the Wisdom and Power of that Divine Mechanic alone, who has contrived and constructed the still more complicated mechanism of the universe.

There are few subjects connected with the physical structure of the earth, better calculated to excite our curiosity and reflection, and, in the end, our unbounded admiration, than the systems of valleys so universally distributed over the earth's surface; and to the existence of which are due, that picturesque beauty, and that salutary drainage, so conducive to the health, the happiness, and the general welfare of mankind. These valleys prevail so uniformly over every habitable land, although marked with every variety of depth and form, that, to the reflective mind, they are continually obtruded on the view, and forcibly demand our deepest attention and study*. In traversing the wide spread continents, as well as the smaller islands, we find that we no sooner quit one valley, or system of valleys, than we enter upon another; and that we can scarcely discover a single point, in taking an enlarged view of the surface of the dry land, where, if a fluid were set at liberty, it would not flow either towards one hand, or towards the other; and eventually be guided through a more or less complicated group of valleys, *to the exact level of the sea*, that vast reservoir, from whence all land-springs, however elevated, derive their origin, by condensed evaporation.

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* A paper upon this subject, was read by the Author at the Scientific Meeting at Stuttgard, in September 1834.

The phenomena of valleys, have, as might naturally be expected, frequently occupied the attention of philosophers; and various contending theories have been, from time to time, advanced, in endeavouring to account for them. I shall at present confine myself to only two of these theories, as coming from two of the most able geologists, and as constituting the ground work for the most common and popular opinions, on the subject. The learned author of the Bridgewater Treatise on Geology, in speaking, in a former work, of valleys of *denudation*, says: "Though traces of Diluvial action are most unequivocally visible over the surface *of the whole earth*, we must not attribute the origin of all valleys exclusively to that action. In such cases as we have been describing," (alluding to the valleys of the oolite, the chalk, and other soft sedimentary formations,) "the simple force of waters, acting *in mass*, on the surface of gently inclined, and regular strata of chalk or oolite, is sufficient for the effect produced. But in other cases, more especially in mountain districts, where the greatest disturbances appear generally to have taken place, the original form in which the strata were deposited, the subsequent convulsions to which they have been exposed, and the fracture, elevations, and subsidences, which have affected them, have contributed to produce valleys *of various kinds*, on the surface of the earth, *before* it was submitted to that *last* calamity of a Universal Deluge, which has finally modified them all*."

It thus appears, according to the testimony which was formerly borne to diluvial action, by this able writer, that there are two distinct species of valleys; one, of *denudation*, and originating in the action of the deluge; the other of *elevation*, or arising from subterraneous convulsions, *previous* to that event†.

The second theory to which I propose to allude, is that of the author of the "*Principles of Geology*," who attributes valleys to a long succession of *upheavings* of minor character, cracking and deranging the strata of the earth's surface; and he supposes that the work of degradation, by aqueous causes, was subsequently accomplished, *during an immense lapse of ages*, and chiefly by the action *of the sea*. "If the rise of the land," says he, "and its degradation by aqueous causes, was accomplished *by an indefinite number of minor convulsions*, during an immense lapse of ages, we behold *in the ocean,* a power fully adequate to perform the work of demolition. If, on the other hand, we embrace the hypothesis of paroxysmal elevation," (that is, such convulsion as the Mosaic Deluge is described to have been,) "or, in other words, if we suppose a submarine tract to have been converted, *instantaneously,* into high land, we may seek in vain for *any known cause,* capable of sweeping away even those portions of chalk, and other rocks, which, all are agreed, must once have formed the prolongation of the existing escarpments*."

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* *Reliquiæ Diluvianæ*, p. 258.

† Dr. Buckland "*On Valleys of elevation*," Geological Transactions, February 1825.

In another place, this able writer states, in explanation of the theory which he advances, that "the excavation of valleys must always proceed with the greatest rapidity, when the levels of a country are undergoing alterations, from time to time, *by earthquakes;*" and that "it is principally when a country *is rising or sinking,* by successive movements, that the power of aqueous causes, such as tides, currents, rivers, and land-floods, is exerted with the fullest energy. In order to explain the present appearance of the surface," (speaking of Sicily,) "we must first," says he, "go back to the time when the Sicilian formations were mere *shoals* at the bottom of the sea, in which the currents may have scooped out channels here and there. We must next suppose these *shoals* to have become *small islands,* of which the cliffs have been thrown down, from time to time, as were those of Gian Greco, in Calabria, during the earthquake in 1783. The waves and currents would then continue their denuding action, *during the emergence of these islands*, until, at length, when the intervening channels were laid dry, *and rivers began to flow*, the deepening and widening of the valleys, *by rivers and land-floods*, would proceed in the same manner *as in modern times*." In another place, this author adds, "the time required for upraising a mass of land to the height of several hundred yards, must usually be *so enormous*, (assuming, *as we do*, that the operation is effected by ordinary volcanic forces,) that the aqueous and igneous agents will have time, before the elevation *is completed*, to modify the surface, and to imprint thereon the ordinary forms of hill and valley, by which our continents are diversified. But *after the cessation of earthquakes*, these causes of change will remain dormant, or nearly so*."

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* *Principles of Geology,* Vol. III., p. 309.

We thus find that all the valleys on the surface of the earth have been attributed, by both these able Geologists, either to subterraneous elevatory movements, producing chasms and great fissures, which were subsequently modified, and rounded off, by the action of waters, or to this latter action alone. There seems, however, to have once been a wide difference of opinion between the two, as to the rapidity and duration of the process, as well as with regard to the original nature of the abrading aqueous action; the one adopting the theory of the long-continued natural friction of rivers, forming, or at least greatly enlarging, their own valleys; and the other preferring the *simultaneous* action of the descending waters of a Deluge, the effects of which he was then employed in describing*.

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* *Principles of Geology*, Vol. III., p. 114, &c.

It becomes necessary, in this place, to take notice of one of the opinions above advocated, and which seems to be extremely prevalent among general observers, with regard to the action of rivers *forming*, or *enlarging*, the valleys through which they flow. To any one who has studied from nature, the character and *combined* mechanism of valleys, this idea might be regarded as so unnatural, as to be almost unworthy of serious refutation. For when we look at the great width and depth of many valleys, and then consider the comparatively trifling extent, to which even the highest floods in the rivers which occupy them, can attain, we cannot possibly suppose that so small a supply of water could ever have produced such vast effects, even admitting, with the above authors, unlimited periods of time for the operation. If such had been the origin, or even the assisting cause, of valleys, we should naturally expect to find the proportions of a valley increase, in the exact ratio of the increase of the size of its river; and, consequently, that, towards its source, the valleys should gradually diminish, and finally altogether disappear, exactly at the highest springs. It is scarcely necessary to show that, so far from this being the case, we constantly find a continuance of the same well defined, and smoothly rounded valleys, which we had observed in the middle and lower courses of rivers, to be extended deeply into the hills, *far above the highest springs.* It will not, of course, be asserted, by those who advocate the ceaseless laws of existing nature, in accounting for all the phenomena now visible on the earth's surface, that the rivers must once have been larger, and more powerful than they now are. To assert this, would be to suppose, that the atmosphere was differently constituted, and that it formerly produced a greater supply of water than it now does, on any part of the earth. But if the continuance of well defined valleys, above the highest sources of existing rivers, be not sufficient for the refutation of this idea, what argument can be adduced in support of this theory, in the case of the innumerable valleys which are entirely destitute of flowing waters; and which yet universally present *the same inclined planes,* and the very same winding and *rounded forms* which constitute the leading features of the valleys, through which the largest rivers flow? Such *dry* valleys are every where to be seen. No one (except indeed, an inhabitant of the fens,) can leave his own house, and study the character of the nearest sloping ground, however distant it may be from flowing waters, without discovering that it communicates with some neighbouring valley, though perhaps by a tortuous course, which valley opens into a lower one; and that water, if set at liberty on the inclined ground where he first began, would thus, at length, be guided to the lowest level on the earth's surface, that is, to the surface of the surrounding ocean. This is a fact universally prevalent, over every part of the existing dry lands, and one which cannot be overlooked by any inquirer who is desirous of tracing to their cause and origin, the universally *inclined planes,* which now constitute the earth's surface. Such facts are so *common,* and so constantly before our eyes, that few will give themselves the trouble of thinking deeply upon the subject. The moment, however, that the attention is aroused to what no one can then fail to perceive on every hand around him, the face of nature becomes decked with a new source of interest; and the inquiring mind derives a new pleasure, even when contemplating the barest and most barren downs.

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* I should gladly have availed myself of any distinct *subsequent* opinion on valleys, published by the first of the able authors I have just quoted. In his last work, however, (the *Bridgewater Treatise*,) he scarcely alludes to this beautiful part of the natural proofs of *Design*, exhibited on the earth; and while we find, from the note already quoted, that he no longer attributes valleys to the effects of the Mosaic Deluge, which he now supposes to have been *so tranquil*, as to have been incapable of causing any great change upon the earth's surface; we find from other parts of the work, that he now agrees, more or less, with the theories of *slow and gradual* change, which might be effected by volcanic forces, and meteoric action, during the "*millions of millions of years*" which he thinks may have existed, since the creation of the globe.—*Bridgewater Treatise*, p. 21.

It seems, then, to be entirely inconsistent with the existing laws of nature, on which so much stress is usually laid, to suppose that valleys could, by possibility, have owed their origin, or even any material share of their present rounded forms, to the action of existing rivers, however long we may suppose them to have flowed*.

In order to enable us to take an enlarged and general view of the admirable combination of valleys, by which *perpetual motion* has been given to rivers, it may be advisable to study the subject on a more extended scale than the limits of our own island will afford; and we can, from thence, the more readily descend, to the minute subdivisions of valleys, and to a scale of even the smallest dimensions. We may take, by way of example, the territory of France, as being not only of considerable extent, but as presenting a continued breadth of table-land, of moderate elevation above the sea; and internally composed of a succession of almost all the geological formations, which, from granite up to the most recent strata of the Paris basin, successively come to the surface, in the long course of the *inclined planes*, over which the waters flow, from the mountains of the Vosges and Jura. Having myself lately traversed that country, for the express purpose of tracing out the systems of valleys, and of examining their phenomena, I can, the more confidently, present the reader with the following reflections on the subject.

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* It will probably be considered vain, by some geologists, to refer, in this place, to the trifling changes that have been effected, even by the strongest rivers, during so short a period as two thousand years. It may, however, be satisfactory to others, to remark, by way of example, that in the valley of the Rhone, and at that part of it against which the Alpine torrent called the Dranse, has incessantly poured its precipitous current during twenty centuries, we can now stand upon the ancient Roman fort called *Octodurum*, so well described by Cæsar, in the third book of his *Commentaries;* and can still, from thence, trace the exact positions of the contending forces, which he gives us in the first chapters of that book. The Dranse is a torrent which is constantly and powerfully affected by the avalanches, and meltings of the neighbouring glaciers, from whence it flows: and it was this stream which occasioned, in 1818, the instant destruction of a great part of the town of Martigny, from the sudden bursting of a temporary lake, which had been formed by the accidental fall of a mass of ice, which, for a time, obstructed the current of the stream. There is no perceptible change in the rocky structure of the fort, at the confluence of the Rhone and this torrent.

France has already been described as one continued table-land, with but few variations, from a certain moderate elevation above the sea. These variations consist chiefly of the smooth and rounded ridges of the Vosges and Jura, on the eastern side, from whence the Seine, the Loire, the Meuse, and the Moselle take their rise. These rivers, with their innumerable tributaries, form the system of drainage over the northern half of the kingdom, as may be seen by any good map of France. It may here be remarked, that so regular and uninterrupted are all the inclined planes of this part of France, that no *lake* nor *waterfall*, of the least importance, is any where to be found. The whole country presents one continued smooth outline, intersected only by deep valleys. These valleys are hollowed out in the most easy and serpentine courses; and numerous as are the tributary streams which fall into these main drains, they bear no sort of proportion to the innumerable *dry valleys*, of precisely similar forms, which also open, in all directions, into the river-courses, as they tend towards the level of the ocean.

Now if we suppose, (by way of illustration,) the case of a surveyor, who is employed to improve, by extensive drainage, some moist and unreclaimed tract of land, we shall find him first studying the general line of the country, and observing the lowest level by which he can obtain an outlet for his general drainage. He then marks out the line of his main drain, which, if large, and intended to contain much water, must have the easiest possible inclination, in order to avoid the injury which a more rapid fall would occasion to its sides. He then proceeds to line out the side drains, according to their size, and the varied forms of the ground; thus proceeding from great to smaller, until the whole plan is completed in theory, and the labourers are appointed to put the projected work in operation. If the whole ground have but little slope, it would become a point of skilful levelling to fix, before hand, the exact depth of each side drain, at any given spot, so as to derive the utmost possible advantage from what little fall there may chance to be. If, on the contrary, there were no want of slope, the most common labourers might carry on the work. The general rule, however, in such operations, is to avoid a *rapid* fall, and also to remove even the smallest interruption to the current; as both would occasion severe friction, and might consequently lead to much damage and expense. In the execution of such a plan, it is scarcely necessary to say that the work could not be begun either *in the middle*, or *at the top*. In either case, the water would accumulate, and obstruct the labourers; but a still more important evil might occur, from *the loss of level* in working downwards, causing the lower part of the drains to terminate, *below* the only levels by which their waters could escape, and thus destroying the effect of the whole plan. An artificial drainage is begun at the lowest possible level, and is invariably carried on *upwards*; and thus, at every side drain, the proper depth is exactly kept, and the waters, as they gather, escape freely at the point of outlet.

I have been thus minute in describing what occurs in a work of *art*, in order, the more clearly, to show the effects which have been produced, in the works of nature. The Loire at Nantes, the Seine at Havre, the Meuse in Holland, and the Moselle at Coblentz, are the main drains of the larger half of the French territory; and in tracing the courses of those drains, from their *emboucheurs*, up to their highest sources, we find endless side drains, of every size, falling into them; these latter having again their own systems of smaller tributaries, and so on upwards, till we reach the summit level of the great table-land, and the highest springs from which the waters flow.

The annexed sketch will serve to show the simplicity and beauty of such natural drainage, resembling, as it does, the complex mechanism of the veins and arteries in animal and vegetable bodies. But the subject of most importance to our present purpose, in studying this beautiful system, consists in the *uniformity* which is so remarkable, between the form and structure of the numerous tributary valleys, which are occupied by rivers or brooks, and those innumerable *dry* valleys, which, in like manner, fall into the line of the general drainage, *each side drain in succession, whether dry or otherwise, entering the one below it exactly at that point of*

Explanation of the Sketch.

Fig. 1. The drainage of a country, exemplified in the river Seine and its tributaries, exclusive of thousands of *dry valleys*.

Fig. 2. An example of a similar drainage, where a lake may chance to occur.

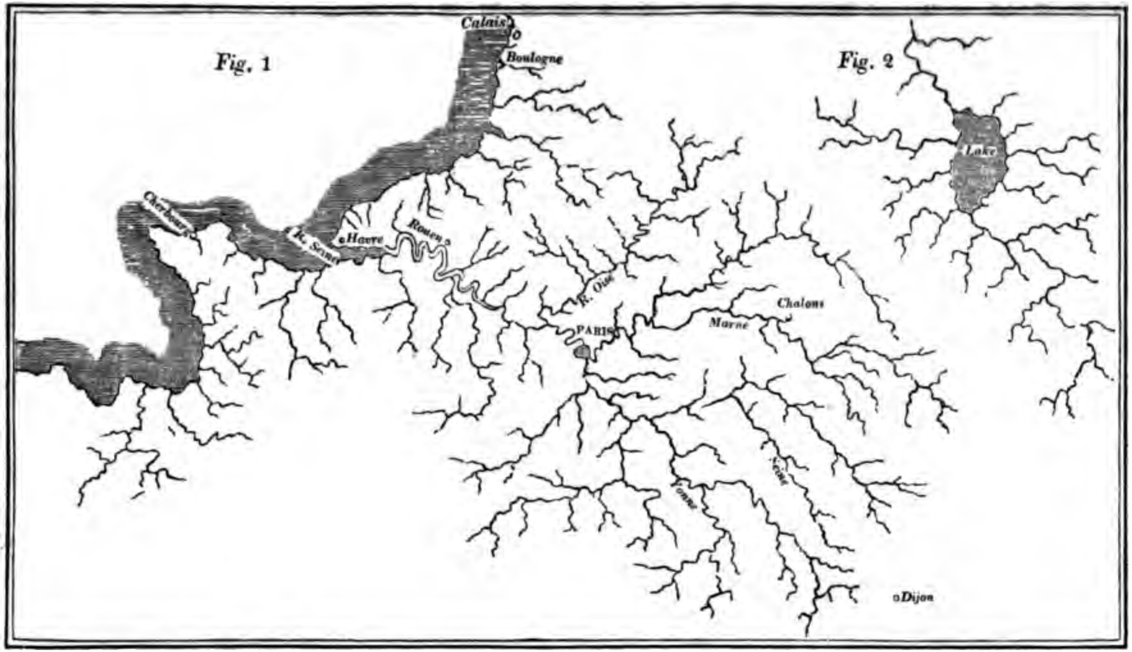


Fig. 1

Fig. 2

Calais
Boulogne
Cherbourg
R. Seine
Havre
Rouen
R. Oise
PARIS
Marne
Chalons
Seine
Yonne
Dijon
Lake

level where it naturally would enter, supposing the whole to have been the simultaneous work of one system of aqueous agency.

Now, it must be very evident, that if the valleys of this part of the Continent had been formed in the manner described at page 110, *viz.* by chasms and fissures, occasioned, in the first place, by subterraneous convulsions, and afterwards smoothed down and modified, by the flow of currents, during an immense lapse of ages; it must, I say, be evident, that, in such a variety of rocks as occur in the inclined planes of the Seine or the Loire, such convulsions must have left the surface of the country, in a state of the greatest disorder, *in point of level;* and instead of the existing series of *gently inclined planes,* cut through *granite,* as well as all the softer secondary rocks, there must have been innumerable hitches and interruptions, which would have occasioned lakes of every depth, and cataracts of every degree of height, throughout the rivers' courses. Under this impression, we can conceive no just reason, why a great tributary system of valleys, *originating in a distant province,* should *always* chime in so exactly, and in such beautiful accordance, with the general system of drainage. Why should the Moselle, in its winding and rocky (though navigable) course, passing, as it does, through the vertical transition rocks, fall with such exactness, into the main drain of the Rhine at Coblentz?

Why, again, should the *dry* valleys, and smaller river courses, which fall *to the eastward*, from the Vosges into the Rhine, by Colmar, acquire, in only *fifteen or twenty miles*, the exact same levels in the Rhine which the western streams attain, only after a course of *several hundred miles*, over planes of a more gentle inclination? To take a still more striking instance of the same sort, why should the short and precipitous valleys, falling *westward* into the Rhine, from the summits of the Black Forest, reach their proper respective beds, in that navigable stream, within a very few miles distance, while the waters which flow *towards the east*, and fall into the Danube, have to make an easy and gliding passage of nearly *two thousand miles*, in order to reach the same general level?

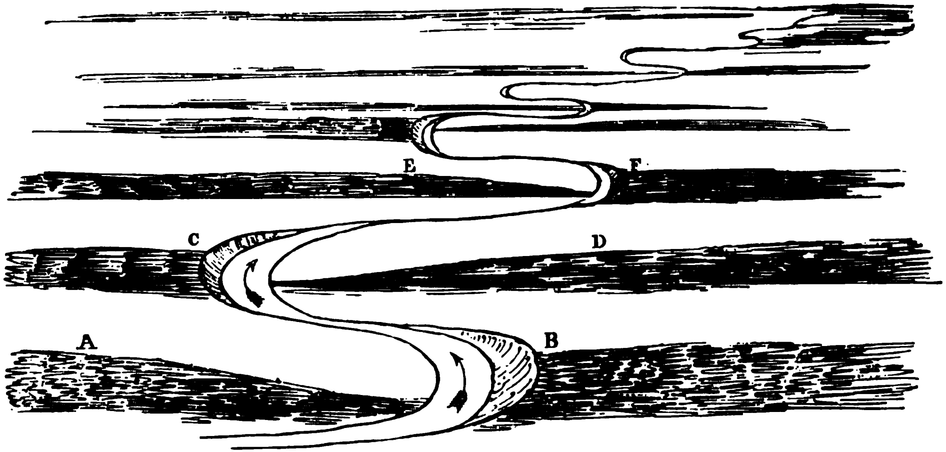
In other words, what consistent reason can the supporters of the theory of *fissures* give, for those on one side of a range of mountains being *deep* and *short*, while those of the other side, *(commencing at the very same summit level,)* are extremely shallow, and of the most easy and gentle inclinations? Nor can it be said, in the instance of the Black Forest, that the fissures, so called, have been filled up, and thus modified by aqueous action; for, on both sides, when we closely examine the beds of the streams from top to bottom, we find the strata of the rocks *undisturbed* and *continuous*, from one side to the other of the valleys.

Do not these, and thousands of similar instances of exact accordance, and general arrangement, in the systems of natural drainage over the earth, loudly proclaim a *simultaneous* origin, a *unity* of cause? We may, indeed, observe miniature models, both of this system, and its most natural *cause,* in the muddy continents and islands left dry by the ebbing tide in our harbours. We there see a generally *rounded* surface; an almost total absence of *precipices;* a variety of levels; occasional ridges of mountains; extended plains; and, above all, a universal system of smooth valleys, and river courses, strikingly similar to the great scale of nature, and all tending, in like manner, and in like accordance, to the same general and surrounding level of the sea.

Having thus shown that the idea of a *simultaneous* origin of all valleys, is more consistent with their existing features, than that which is entertained by some geologists, of *repeated convulsions during immense periods of time;* and having pointed out, in their arrangement, a strict analogy with what we see in nature, on a small scale, arising from *simultaneous aqueous agency,* we may now follow up the thread of our argument, with a fair prospect of unravelling the labyrinth. With this view, let us examine more nearly, the course of a valley, and observe whether its more minute parts corroborate or controvert the idea of *aqueous* agency.

The first universal feature which must strike every one, as characteristic of valleys, is their *rounded* and *serpentine* course. Taking this, then, as a *universal* principle from which to start, it is for geologists to point out, by strict analogy with nature, by what laws of fracture, rocks could be supposed to break up into this particular form, in the event of such subterraneous convulsions as have been above supposed. We all know, on the other hand, that when water is allowed to work its own course, over a gently inclined plane, of yielding materials, it invariably falls into the above winding and serpentine form, the smallest resistance being sufficient, gradually to turn it into a fresh direction.

The next great feature characteristic of valleys, exactly resembles what would be the natural result, from a great and powerful flow of waters. We find, on an examination of the rounded sweeps, that the sides of a valley are, *alternately, steep on one side, and of a very easy slope on the other;* so much, indeed, does the effect resemble what occurs in small runs of water, at the present day, that a superficial observer would at once conceive that the whole valley must have been formed, by a long continuance of similar action; forgetful, or ignorant, that great valleys, occupied by mere brooks, present the same phenomena; and that even in those that are perfectly dry, we also find similar forms. Those who are best acquainted with Scottish rivers, such for example, as the Tweed, the Gala, the Leader, the Tay, &c. will find that there are alternate *heughs* and *haughs,* as they are provincially termed, that is, precipitous banks, and rich and gently-sloping lands, throughout the whole courses of these rivers. Towns and old abbeys are, in Europe, generally found to occupy the rich soils of the latter; while ruined castles frequently bespeak, on the former, the commanding or protecting neighbourhood, of some old baronial fortress. *These forms alternate, from right to left,* and this almost *without exception;* for there is no instance of a bend to the *left,* in a well defined valley, without the steeper ground being seen on the *right,* with a low carse land on the *left,*—and *vice versa.* On following the bend, at the steeper side, we find that this steepness gradually subsides. The valley then, perhaps, continues for a short distance, in nearly a straight direction; we soon find ourselves on low ground, and observe a similar steepness commencing on the other side the valley. This change denotes a speedy bend, and so on, throughout its whole length. The annexed outline will assist in explaining these facts; but nature alone ought to be consulted on the subject; and no one can go far, without perceiving abundant instances of what has now been but imperfectly described.



Sketch showing the forms of a great valley, at various sections, in traversing a table-land. The real width of the valley is from A to B, C to D, &c.

It is in such wide extents of table-land, as are seen in France and Germany, however, that such phenomena are studied to the greatest advantage. In a late journey up the Seine, from its mouth at Havre, by Rouen, to Paris, and from thence throughout almost its whole course, up to Dijon, I observed with wonder and delight, a continued and *invariable* succession of such forms. In the valleys of the Mayn, the Neckar, the Danube, &c., we also find these forms most beautifully developed.

In viewing those circular windings of inland valleys, remote from the sea, before having obtained an insight into the subject now under our consideration, observers, taking a limited view of individual windings, often fall into the common error of supposing *each* of these to have been the site of an ancient lake, which has *burst* its boundaries, and thus been laid dry, during some ancient convulsion. The fossil remains of quadrupeds, &c., often found in such valleys, are, in such cases, accounted for, as having been washed into these supposed lakes. There is, perhaps, no supposition more erroneous in Geology, than that such a state of things ever existed in our present valleys ; for we must remember, that in such a long succession of supposed lakes, each must have been *lower* than the one immediately above it, in the series : and yet, so slight is the present slope of the winding *inclined plane*, and so close the junction of one bend, with its neighbour, that the former existence of *embankments* is obviously impossible, and the whole is at once, more naturally accounted for, by the descending action of *one flow of waters*, during which, such fossils must have been deposited, as are now found in the superficial diluvial covering, which now reposes so universally over the surface of the country. Such are the errors into which a limited view of things may sometimes lead even the ablest scientific men*.

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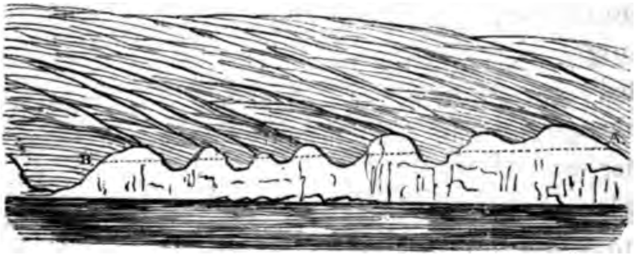
* I may here give the following instance as an example of the above error. During an extensive study of the valleys of Germany, I had been especially struck with the innumerable beautiful windings, in the long vale of the Neckar, and with the regularity of such alternate slopes and precipices, as have been above described. After the Scientific Meeting at Stuttgard, in September 1834, I was one of several persons, who were invited to visit Canstatt, a few miles below the city, a place rendered remarkable, by the fossil deposits of elephants, and other quadrupeds, which have been already alluded to at page 22. We were under the guidance of one of the Professors of Stuttgard, a most obliging and amiable man, who had long taken a deep interest in the fossil discoveries of this locality, and who now pointed out to us, in one of the beautiful circular bends of the valley, the spot where the *embankments* of a former lake *must formerly have been*, when these deposits were washed into it. This explanation of the subject was regarded by all present, except myself, as so perfectly clear and satisfactory, that any attempt to propose a different solution, would have been vain. But having, myself, just completed an examination of *the whole course* of the Neckar, from its very source, down to Hiedelberg, and having seen *many hundreds* of such windings, both above and below Canstatt, the chronological key to all of which, I had previously discovered on the sea coast, at the opening of these valleys to the ocean, I could not subscribe to the idea of this *one* lake, without concluding that the whole

The third and last marked feature of which I shall take notice, with respect to valleys, is that geological structure of their sides, on account of which the name of valleys of *denudation* has been very properly applied to them. In countries where the formations are of a varied nature, that is, where the horizontal strata are so thin, as to be exceeded by the depths of the valleys, we can generally trace in their sides, the outline of each species of rock; and, if found in the *heughs*, or steep escarpments at the bends, we are frequently enabled to examine their lines, and mode of junction. When such exact correspondence of the strata occurs, on each side of a valley, as is constantly seen in the secondary countries, (such as the whole of the south of England, and nearly the entire width of France and Germany,) we have proof to demonstration, that such valleys were not, and could not be, occasioned by *fractures*, from an *upheaving* force; but must, on the contrary, have been *scooped out* from the solid, and nearly undisturbed beds, of various sorts. That such scooping agent, was a force of *descending waters*, we may clearly infer, from the fact of each valley forming an inclined plane, of sometimes *hundreds of miles* in extent, but ending *exactly*

course of this and of every river, had once been a long succession of lakes, all of which must have thus *burst their banks at one time*, without leaving a solitary instance, by way of specimen, to explain how such bursting was effected, or how the embankments were so smoothly effaced, as not to have left even a vestige, to point out their former site.

at that point, where such aqueous agent would naturally be deprived of its scooping power; that is, at *the exact level of the ocean.* We also have conclusive proof that this action was *simultaneous*, throughout a whole continent, in the fact of each tributary valley, chiming in so harmoniously with the one below it, and exactly at the proper level. The following sketch of a part of the Sussex coast, near Cuckmere, may serve, by way of example, to show the undisturbed nature of the strata, through which numerous dry valleys have thus been cut. The ridges, between these coombs, are there termed, the Seven Sisters. The lines of flints are seen, in the cliffs, to be *continuous* and *undisturbed*, across the openings of all the valleys, from A to B.



Now, had such valleys originated in subterraneous upheavings, though subsequently modified, and rounded off, by diluvial action, we should have naturally expected to have found, in the cliffs, some such appearances as the following, with the chasms filled up with such diluvial loam and gravel, as form the general covering of the neighbouring country.

It may perhaps be said, however, that though these facts form a strong case, in favour of exclusively *aqueous* agency, in the instance of the valleys of soft secondary formations, and in countries of a plain and simple outline, such as France and Germany, yet, that in the mountain districts, and especially among the schistoze and granitic rocks, we cannot possibly refer to the powers of *water* alone, such deep and precipitous glens as generally prevail there. I have no intention of entering upon the question as to the origin of mountains, to which we might here be led; but shall prefer adhering tenaciously to the thread which is supplied by the low-land valleys, for unravelling the mystery regarding more Alpine glens. In the case of the Moselle, for example, to which I have already alluded, nearly the whole of its channel is cut through primary, or transition rocks; and in a course so beautiful, (and, at the same time, so *gently inclined* as to be navigable,) that few rivers can present a more romantic course, for upwards of one hundred miles, from Treves, down to Coblentz. Here, then, we find a valley of great length, cut, (as if in order to be navigable by the exact levellings of the most skilful surveyor,) through *vertical* beds of schistoze rocks, with all the beauty of a serpent's windings, and with many thousands of small and *dry* valleys entering it, on every hand, the examination of the mouths of all of which, shows, that they have never been *fissures*; for the solid and *undisturbed* beds of rock can invariably be traced from one side to the other; and yet each of these *dry* valleys, enters the main drain, *at a different level from its neighbours*, though without there being, in any one instance, either an abrupt fall, or too great a hollow! Nor is this all; for we find that this noble stream is, itself, but a tributary to the still greater drain occupied by the Rhine, which, at the point of confluence, and for many miles above it, is also cut through similar vertical rocks. We find the Rhine, in like manner, urging its way through rocky impediments, and joined on either hand by valleys, generally *dry*, but of the same exact and artist-like construction.

Had all, or any of such valleys, been the result of *fissures*, we must have found of very frequent occurrence, in river courses, such sinking, and disappearance of the waters, as we occasionally, though rarely, see in some limestone districts. There are, in Ireland, some curious instances of subterraneous streams, from the cavernous nature of the limestone prevailing in some districts. The well-known instance, also, below Geneva, on a larger scale, of *La Perte du Rhone*, where that river sinks into a hollow, from its valley happening to intersect the Jura limestone, will serve to invalidate the whole theory of fissures. For it is well known that the cavernous nature of such limestone, is not confined to the *bottoms* of valleys; but, on the contrary, prevails throughout, whatever may have been its cause: and we also find, in the curious cave district of Franconia, that such cavities could not have been occasioned by convulsions, or earthquakes; for in the sides of some of the valleys, we see two or three distinct formations, one above the other; while the caverns are strictly confined to that alone, to which the title of *cavernous* has very properly been given. Had a convulsive, upheaving movement, given rise to these caves, we must have seen such rents communicating, both above and below, with the neighbouring strata. *La Perte du Rhone*, then, affords no argument in support of the theory of fissures: on the contrary, it is strongly opposed to it, as showing, in an almost *solitary* instance, what must have been of very frequent occurrence, in valleys of every formation of rock, had such fissures been occasioned by such upheaving force as some geologists advocate, in accounting for the origin of valleys.

Having, then, become satisfied of the *aqueous* and *simultaneous* origin of the systems of valleys, in the less elevated districts, we can discover no place, in proceeding upwards in their course, and downwards in the relative age of the rocks through which they are cut, to pause, and to draw a line of distinction, as to the *mode* by which the whole of this mechanism has been so beautifully constructed. The whole must be viewed as the combined parts of *one vast machine*, intended for a particular and most beneficial purpose; and fulfilling that intention with as much precision, as the numerous other mechanisms which we every where see in nature. We cannot divide and subdivide its execution, into such *periods* as may suit our other theories. Here we have conclusive evidence of *unity* in all the parts, although we may have, as yet, found no gleam of light, to lead us to the particular *period* when the whole machine was completed. One point of some importance, however, we may be admitted to have established; *viz.*—that the flow of rivers must necessarily have commenced, *on the very first day that the present dry lands became elevated above the waters*, with which they are, on all hands, admitted to have been, at some former time, covered. We have, as yet, adduced no evidence, in attestation of that particular period; but as the whole system of valleys must have arisen *simultaneously*, and must also have required a certain force of action, which the evidences show to have been that of *descending waters*, we have demonstrative proof that our continents did not become elevated, as is now very commonly supposed by geologists, *by long continued, and successive upheavings;* a mode which could, by no means, have produced that simple uniformity, which the surface of our dry lands now exhibits.

CHAPTER IV.

ON LAKES AND WATER-FALLS. THE FALL OF THE RHINE AT SCHAFFHAUSEN; WITH THE EVIDENCES IT AFFORDS OF A VERY RECENT ORIGIN.

HAVING, in the last chapter, given a general outline of the simple though vast mechanism, to which the additional wheel was alone wanting, of such water as constantly falls from the atmosphere, in order to produce that *perpetual motion* in rivers, to which I have already alluded; and having shown that this mechanism must have been *simultaneously* constructed, in order to produce that universal harmony which prevails throughout all its parts; it now becomes necessary to notice the only two species of interruption which occur, in the inclined planes of valleys; I mean that of *lakes*, and of *water-falls;* the former being *below*, and the latter *above*, the common slope of such inclined planes. It may possibly appear, on a minute scrutiny, with regard to these rare exceptions to a general rule, that evidences may be found in both, either corroborative, or otherwise, of the system we have now under our examination.

There appear to be two kinds of districts, in which *lakes* are more usually found; and the characters of these are so diametrically opposed to each other, as to lead us, at once, to the idea of these lakes owing their origin to two equally distinct causes. These districts are, generally, either low and flat, such as Holland, some parts of Ireland, &c. where the lakes are usually shallow; or mountainous regions, where they are frequently not less remarkable for their great depth. The lakes in the former districts, seem evidently to have arisen from merely casual hollows, which have occurred where the force of that aqueous agency, to which we attribute valleys, had become greatly reduced; and, consequently, incapable of sweeping away the points of resistance, which now obstruct the flow of waters. These shallow lakes, or *meers*, frequently admit of partial or total drainage; and their basins almost always present the same easy inclinations which are seen in the surrounding country. They are often seen nearly filled up with recent vegetable matter, well known under the name of *peat;* and in this form of mosses, they are sometimes converted, by draining, into the richest meadow, or even arable lands. Such low districts, and shallow lakes, it is unnecessary to dwell upon, in this place, as they present no very striking evidences, on either side of the question, now under our consideration. It may, however, be remarked that the rapid growth of *peat*, in hollows which must once have been filled with pure *water*, though now converted into solid ground, by the growth of what all geologists admit to be of recent and post-diluvian origin, corroborates, as far as it goes, the *recent* periods, of which we may subsequently discover more perfect and conclusive testimony*.

With regard to the lakes of mountain districts, which we are now to consider, it is probable that they will be, at once, adduced as proofs of that very upheaving and convulsive violence, to which the evidences already examined, have all been so strongly opposed. But here I must remark, that I have no wish to oppose a fact, which I have always looked upon as self-evident, in the phenomena of mountain districts. I never have doubted the former existence of some unusual violence, by which either the present lands have been elevated above the waters, or the waters have been depressed below the level of the present lands. What I am now, and always have been, opposed to, is, the prevailing geological theory of *endless repetitions of such violence*, as has unquestionably converted the former bed of the sea, into the present habitable dry lands; and which ascribes the phenomena of valleys, &c. to numerous and successive throes, or upheavings, during vast periods of time.

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* It is generally admitted that peat is a recent and post-diluvial substance, and no remains, strictly fossil, have ever been found in it. Those of the great Irish elk, have been sometimes called fossil, occurring, as they do, in mosses, or in the marl beneath the peat; but I have lately examined a specimen well calculated to settle this question in the negative. In the Museum of the Royal Society of Dublin, there is a splendid and perfect skeleton of the elk, with its enormous palmated horns, from a bog in Ireland. In another bog, an elk was found, *with some parts of the skin and hair well preserved.* In the same museum, a foot, and part of the leg of this specimen, are seen, as perfectly dried and preserved, as if prepared by an anatomist. The hair is short, of a bright brown colour, and the hoofs large and black. No *fossil* animals have ever been seen in this connected and well-preserved condition, except in those instances which occur in very high latitudes, where they have been hermetically sealed up *in ice*, and been thus preserved in the very same condition as when first embedded.

It has been already stated, while describing the mechanism of valleys, that they can generally be traced, in an almost uninterrupted course, from the highest Alpine summits, to the exact level of the sea. The lakes of the higher districts, usually form exceptions to the regularity of these inclined planes; and as it is very evident that the scooping force in question, has been much more powerfully displayed where the Alpine pinnacles are now seen, the rocky and nearly straight water-courses, which deeply furrow their sides, form a striking contrast to the lower portions of the valleys, which latter so forcibly present to the mind, the evidences of *a powerful, but not precipitous, flow of waters.* It is in these Alpine regions alone, then, that we can discover the smallest evidence in support of the theory of *chasms* and *fissures*, from an upheaving force. It is, indeed, extremely probable that, to the direction at first given, by these deep furrows, to that descending power of waters, of which we, every where else, see evidence, are due the particular directions and courses, which the currents afterwards thus fortuitously took. The lakes of the mountain districts are frequently, and indeed generally, of very considerable depth; so much so as strongly to favour the idea of their often being the deeper parts of such chasms in the rocks, as would naturally result from some violent convulsion. An instance of this, of a very striking nature, is found in that singular division which cuts Scotland from sea to sea, and through which the Caledonian canal now passes. That division presents many of the characteristics of a true *fissure,* and may serve to show what all valleys *ought to have been,* had they resulted from a like cause. It is about one hundred miles in length; of a narrow form; straight in its direction; and has once been entirely filled with water. This water has, however, subsequently given place, in certain parts, to great accumulations of diluvial sand and gravel, by which the depth of the fissure has been greatly changed. These accumulations have been deposited near the mouths of extensive groups of mountain valleys; and the whole chasm has been thus converted into various lakes, separated from each other by these diluvial embankments. This kind of accumulation prevails for many miles near Inverness, on that vast scale of magnitude suitable to the numerous valleys, from the eddies occasioned by which, the water-worn materials have evidently been there thrown up: and the canal, which joins these lakes, being entirely cut through this moveable matter, is constantly falling in on the sides, and would soon become useless, if not attended to, with much care and expense. But the fact which most clearly gives to this opening the character of a *fissure*, is this; that there are depths in Loch Ness, which reach far beneath the level of the sea, at either extremity; and thus we find, that nothing but the presence of the above diluvial embankments, on one of which the town of Inverness itself is built, prevents the free entrance of the sea, from end to end*.

But even in that mountain district, the long and straight *fissure* of the Caledonian canal, forms a marked contrast to the more generally *winding* and *rounded* mouldings, of the surrounding systems of valleys, which all bear the same stamp of *simultaneous* origin, and of *aqueous* agency, so universal in those of the table lands of the Continent, already described. In the case of many of the Alpine lakes of Switzerland, we find a like probable combination of *fissures*, subsequently modified by aqueous action. They are found, by soundings, to exhibit a general correspondence between the forms of their beds, and the neighbouring banks; and thus, by a continuance, under water, of the precipitous, or shelving form, of the solid rocks above, they strengthen the idea of original hollows, entirely independent of any aqueous agency. But we must keep in mind, that lakes are, in all countries, but rare exceptions to the almost general rule of valleys. We are so much accustomed to dwell upon the picturesque beauties of the lakes of Scotland, of Ireland, of Westmoreland, of Switzerland, and of Italy, that we are apt to forget the singular fact, that, excepting the vast inland seas of North America, and some solitary instances of lakes in other countries, we comprise, in the above short list, and in the still more limited districts named in it, almost the only important lake districts in the whole world. But to whatever origin we may attribute the lakes of the mountain districts, there is one universal fact respecting them, which singularly corroborates the powerful evidence already adduced, of the *simultaneous* formation of all valleys, through the agency of *descending waters*. It has been already explained, that in the inclined plane of any valley, each individual tributary falls in, *at its own proper level*, and entirely distinct from those above and below it. In the case of all inland lakes, on the contrary, we see, (what indeed an aqueous agency might be expected to produce,) that the valleys which fall into their basins, are scooped out, on all hands, *exactly to their level, and no deeper:* and the cause of this fact is obvious; for, as in the case of the sea, below the level of which, the powers of aqueous agency would cease, and the valleys would come to an end; so in the basins of inland lakes, by whatever cause these hollows were produced, a temporary cessation of the scooping power of currents, would also occur, and the valleys would, in like manner, come to an end. This may be seen, by examining any lake, with its tributary valleys, which may occur in a district of *solid rocks:* for in the establishment of such facts, all merely *alluvial* districts should be regarded as insufficient. A sketch of a lake, and its rivers, is given in fig. 2, of the sketch at page 120. When we find that in the course of the long inclined plane of an entire continent, (such, for instance, as that of North America,) the tributary valleys which fall into the *river* courses, have each *a different level* at their terminations, while those that fall into the *lakes* have all exactly *the same level*, and this repeatedly, as the alternate rivers and lakes occur; we are surely justified in coming to the conclusion, that no fact in physics is more fully proved, than that *a simultaneous power of descending waters*, was the universal agent in the simple but beautiful construction of the mechanism of valleys.

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* It is a fact which excites the wonder of many, that there should be found a difference of *four feet*, in the levels of the sea, at the two extremities of this canal. The same fact occurs in several other still more remarkable instances, which, with the causes, I have attempted to describe, in a paper, "on the Currents of the Ocean," in the *United Service Journal*, for December 1833.

We may now turn our attention to the only other exception to the general rule of these inclined planes, in the form of *water-falls*, where the *resisting* power of the rock, has been greater than the *scooping* power of the waters; and where, consequently, the weaker powers of the mere atmospheric waters, which now form brooks and rivers, have, ever since, been forced to leap in cataracts. The self-evident fact has been already pointed out, that as the present force of rivers could not possibly scoop out the valleys in which they flow, the existence of these streams is the mere *effect*, and must not, as it has too frequently been, be mistaken for the *cause*. Let us suppose a time, (without, at present, attempting to assign to it a particular date,) when the work of valleys had been completed; and when the descending waters, of which they convincingly assure us, had reached the new level of which they were in search: the existing lands then became dry, and the face of the new land was thus sloped, *on all sides*, towards the sea: the atmosphere discharged, as usual, its condensed vapours, in rain, snow, dew, &c.: the springs of fresh water soon burst from the hills; and the infant streams then received their birth, *on a certain day, of a certain year*. These infant streams naturally sought, by the laws of fluids, the lowest level they could find to flow in. The deep channels in the Alpine summits, first received them: in their downward course, they soon met with other streams, which, like themselves, ran down the hollows of other *previously-prepared* channels. The waters, thus united, became *brooks;* and these brooks were gradually swelled into *rivers* of every size, which, like the mere *rills* from which they sprung, followed such channels *as they already found prepared for them*. If a hollow basin occurred in their course, they already found it occupied by waters in a state of rest. If these waters were *salt*, (which they probably would be,) it would take a length of time to displace them, proportioned to their own quantity, and to the size of the new *fresh-water* stream which flowed in upon them. If, on the other hand, they found an inequality in their course, in the form of a rock, they were violently precipitated over it, and thus, *from a certain day, in a certain year, a power of friction was begun at every water-fall, which has, of course, been ceaseless, and which must continue, as long as the present dry lands exist above the ocean.* Now, as this ceaseless friction of the rivers, never could extend beyond the bounds of the highest winter floods, and would be much more constant in the lower channel of the *summer* streams, we should naturally expect to find corresponding marks of these varied effects, at every such rocky impediment in a river's course. But at this point of our inquiry, a sudden gleam of light bursts in upon the mind; for as we have here a *perpetual motion*, which acts upon the resisting body of the rock, with the regularity of the saw-mill, or of any other artificial mechanism; and as we know that this *ceaseless action* must have commenced *on a certain day*, it becomes clear that we may arrive at the knowledge of that interesting day, if, like the mechanic, we can ascertain the rate of work done, during any given period of time. This may appear a difficult, but it is by no means a hopeless task; and the great importance of the result, in a scientific point of view, is well calculated to repay us for any time or trouble we may spend in the elucidation of it.

The first casual glance at the rocky bed of any mountain torrent is sufficient, when the above idea has once occurred, to convince us of the general correctness of what has just been explained. We may take, as an instance, such a stream as the Tilt, in Perthshire, the channel of which has become known to so many lovers of science, from the surpassing, and perhaps unique *visible*, character of its geological phenomena. To those who have not seen it, it is sufficient to state, that Glen Tilt is one of the thousands of valleys which exhibit, in the Scottish Highlands, the beautiful arrangement of inclined planes, in general accordance, each with the one immediately below it. From the primitive, and consequently refractory, nature of many of the rocks, out of which they have been grooved, these planes are not all so smooth on the surface, as those on the softer sedimentary formations, already described. The inequalities, however, are often but trifling, compared with the general extent of the valleys. They consist of rocks over which the waters have continued to fall, ever since the dry land existed as such; and they, consequently, often present a succession of the most picturesque scenes.

In the whole of this deep valley of the Tilt, (which I have named merely by way of example,) we find a universal covering of *soil*, except in the very bed of the stream. This soil, when removed from the sides of the valley, exhibits the face of the rocks, *in situ*, in a rugged and broken condition, without any of those marks of long-continued friction, which are seen in the channel of the stream, and which *would have been* universally found, had the valleys originated in (or even been enlarged from fissures by) the long-continued action of rivers, as some geologists suppose. The stream itself, though a powerful mountain torrent, is as nothing compared with the width and depth of the glen, in the bottom of which it flows, like a silver thread. During the winter floods, it often assumes an imposing height and force; but on examining the surface of its rocky channel, we at once perceive the utmost height to which it can possibly attain. The soil and vegetation of the sides of the valley, from being deep and vigorous, gradually diminish, and then entirely disappear. The bare rocks, near the verge of the stream, show evident marks of friction, repeated but from time to time; and in descending the remaining depth of twenty or twenty-five feet, they gradually become smoother, until they finally exhibit a polish like that of marble, where the action of the stream has been incessant, for some thousands of years. Similar facts are exhibited in every valley of rapid declivity, and in every river's bed. In the larger streams, (as in the Rhine, between Coblentz and Mentz,) they assume an importance proportioned to the greater scale of their waters, and seem to bring conviction more firmly to the mind. About St. Goar, and the ancient island fortress, called Caub, where there are great beds of transition rock, covered only *occasionally* by the waters of the Rhine, and raising their heads above the stream, (as those called the Seven Sisters,) we see the polishing effects of the current during the lapse of ages, gradually diminishing upwards, and then entirely disappearing, above the highest known flood-marks. Had this great river worked out its own valley, we must have found such water-worn rocks at much greater elevations, instead of their being so strictly confined to the present bed of the stream.

Here, then, we have conclusive proof of the action of rivers being different, from that by which valleys have been hollowed out. Both, indeed, proclaim with equal distinctness, the action *of water* ; but while the former presents unequivocal testimony of the restless, and *long continued* action, of a minor agency, the latter as clearly announces the *transitory* operation, of a stupendous and resistless force.

Having thus explained the construction and movements of this vast hydraulic machine, we must now enter upon the important question, as to the *period* during which these movements have been ceaseless ; and for this purpose, we must look out for such points, as confine the active agent within certain known, and measurable bounds, and thus endeavour to discover, by its present known rate of action in given periods, what time has been necessary to complete the work already executed. It will be at once apparent, that the best defined and most powerful cataracts, in the *softest* rocks, must be the most likely spots to afford us this important information; and the reason is, that it is only in the softer rocks, when violently acted upon, that we can compute the rate of action, during periods within the reach of human memory, or records. And here, we, of the present day, labour under disadvantages, from which succeeding generations may probably be, in some degree, exempt; for it is but within a short period, that careful records of scientific data have been kept; and although, in many instances, we may see the most conclusive testimony, at such cataracts, of the comparatively short period, during which the action must have been in force; yet, it is difficult to arrive at such correct data as are necessary, in order to lead us to the *actual period* of its commencement. Thus, at the celebrated fall of Fyres, in Invernesshire, where the action of the water is now confined in a trough of but a few feet in width, we can distinctly see the spot, where the friction *first began*, in the bottom of a small valley, of no great inclination in the sides. The amount of work already completed, consists of a smoothly polished trough, of a total depth of only about twenty-five feet, narrowing from a width of eighteen or twenty feet at the top, down to not more than seven or eight at the bottom, where the stream now runs. In this instance no one can contemplate the small amount of the *effect*, compared with the great, and well directed violence of the *cause*, and entertain any vast idea of the *period* in which that effect has been produced; but the hardness of the rock, and the slowness of the operation, preclude all hope of ever attaining to any definite date*.

In the more imposing instance of the fall of the Rhine, near Schaffhausen, we have equally clear evidence of a comparatively short period of the tremendous action; and yet so compact is the limestone rock, and so slow is the abrading process, that we are, in like manner, excluded from any reasonable hope of attaining a distinct date. A short description of this celebrated fall, which I have lately visited, and of the evidences which it offers, may, however, prove both interesting and instructive, in this place.

This noble stream, after issuing from the Lake of Constance, flows in an easy, and navigable current, for many miles, between banks of a smooth and rounded form; and, in the latter half of the distance, they are partly composed of a great depth of diluvial gravel, with which the whole bottom of the valley has evidently been left encumbered, to an elevation and extent far beyond the reach of a hundred such rivers. On reaching the spot where the town of Schaffhausen now stands, the vast current which scooped out the valley, was impeded by a compact bed of lithographic limestone, which, however, at length gave way, by a narrow opening of only about seventy yards; and we now admire the picturesque rocks, and the violent eddy occasioned by them, between the mills, on either side*. This resistance, and the direction of the ruptured rock, gave a turn to the valley towards the left; and it then wound its course with one great sweep of about two miles, through hills of sand and gravel, of very considerable height, until it again fell in with a prolongation of the same bed of solid rock, but which, in this instance, *refused to yield*, and the consequence has been, that the subsequent flow of the waters which now compose the Rhine, was obliged to take the awful leap, and thus to commence that violent friction, of which we are now to consider the effects.

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* For a view of the narrow trough, worked out by the Fall of Fyres, see the Frontispiece.

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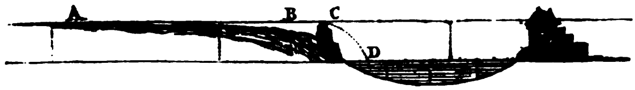
* In these rocks, at the town of Schaffhausen, we have a fine example of a solid *barrier*, having been at length *burst;* and when we hear so much, in *theory*, of the *bursting of lakes*, during the geological periods, while no remnant of their barriers remain, to point out the locality, we cannot help recurring to such instances as this, by way of an opposite example. The bed of compact limestone in this place, is neither broad nor thick, and when the barrier was, at length, burst, it gave way *in a narrow rupture only*, and was not swept off so clean as not to leave its ruins, distinctly to tell the tale. The theory of the bursting of lakes, to which many geological facts are attributed, seems quite gratuitous; for not only are the ruins of the barriers entirely wanting, but we know of no instance of an existing lake, which shows the slightest symptom of future *bursting*.

It is only necessary, before proceeding, to add, that the current afterwards meets with but little impediment, and flows on for many miles, through high banks of diluvial matter, to an extent truly remarkable.

The fall of the Rhine, as we now see it, presents the following profile,



and is broken by two islands, which greatly add to its picturesque effect. A third island gave way before the power of the stream, within no very distant period. On either side of the fall, is a high rock; on one, stands the castle of Laufen, and on the other, some mills, which, however, by no means add to the beauty of the scene. Having the object in view, which I am now explaining, of endeavouring to ascertain, what change had been effected on the rocks, by the incessant action of the current, I instantly perceived, on my last visit, what, on repeated previous visits, I had entirely overlooked. I saw clearly the connection which had originally existed, between the islands, and the rocks on each side. The four points form a connected transverse line, corresponding with that of the rock itself, as it becomes hidden under the diluvial matter, on either side. It is evident that the islands merely consist of masses of the solid rock, fortuitously left by the action of the stream; and that, before they existed as islands, the ledge of rock, which is now being worked back into the form of a steep rapid, was entire; and that the whole body of the stream was originally precipitated, in one perpendicular sheet, ninety feet in height, over the face of this rock, upon the solid mass below. The lower mass, compact as it was, naturally suffered from this continued shock; and, in time, that deep basin was gradually hollowed out, which now forms one of the most striking features in this fine scene. But while this circular basin was being scooped out, the face of the rock could not fail also to suffer, from the ceaseless friction of the waters passing over it. A reference to the sketch will show, where the *rapid* now begins, (at A.) about three hundred and fifty yards above the fall. The rocks which there show themselves above the water, are exactly on a level with the summits of the two islands, (at C.) and in this rapid descent, numerous deep transverse fissures are seen in the rock, well calculated to assist the stream, in the incessant work of degradation. One of the present islands seems likely to stand, as a monument to future observers, of the former extent of the solid rock. The other has every appearance of being one day destroyed; as its foundation is still subjected to a most violent friction, which has already occasioned a deep incision near its base*. The circular and awful cauldron, (D.) of two hundred and fifty yards in diameter, below the fall, usually excites great attention, and is described by the guides, as one of the wonders of the place. I was told, as all other travellers are, that its depth was immense, and not less than four hundred feet! This appeared to me altogether inconsistent with the force of action, from the ninety feet, to which only, even the *original* fall could ever have extended; and with considerable risk and difficulty, I sounded it in several different places, and found it to have the form of a true basin, or shallow cup, the utmost depth of which is not more than about fifty feet.

Thus, it appears, that like many other water-falls, that of the Rhine presents sufficient evidence to establish a very *recent* commencement of its action, although, from the extreme compactness of the rock, and the consequent slowness of the process of degradation, we cannot gather from it any precise data, on which to compute the period. The work already executed by this perpetual motion, amounts only to the destruction of a depth of about twenty feet, at what *was* the highest part of the fall, (*viz.* between B. and C.) To this may be added, a gradually diminishing amount of loss, from that point up to the summit level of the rapids, (at A.) in a distance of about three hundred and fifty yards, above which, the flow of the current is perfectly tranquil. Nor must we omit the basin, of from ten to fifty feet deep, and of two hundred and fifty yards in diameter, which has evidently resulted, as a natural *effect*, from this incessant *cause*. The testimony borne by this latter, is, however, of great importance, as fixing the exact limits, within which this cataract has always been confined. No other such rocky basin is to be found in the whole course of the Rhine; we therefore know, that in the events and periods on which geologists love to theorize, there has never been *but this* serious impediment, since the particular day on which the natural flow of waters which now compose the Rhine, first began to seek the common level of the distant ocean.

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* To those whose heads can bear a giddy summit, the top of one of these islands affords by far the finest view of this noble cataract. I was much more struck with its splendour during the last, than on repeated former visits. The not uncommon disappointment, on first seeing it, arises from the tameness of the surrounding scenery; the fall, to be duly appreciated, must be considered for itself alone.

CHAPTER V.

ON THE FALLS OF NIAGARA, AND THE DISTINCT EVIDENCES WHICH THEY AFFORD, OF A DEFINITE AND RECENT COMMENCEMENT.

IN the observations respecting water-falls, which have formed the chief subject of the preceding Chapter, I have thought it expedient to invert the order in which the phenomena, described in this Treatise, were presented to my own mind; and I shall now, therefore, turn to the evidences afforded by the greatest, and most active of all known cataracts, the lively description of which, by a friend who had seen it, afforded me, in 1833, the first gleam of light which has since become expanded into the entire subject of this Treatise. It was on hearing a description of the very limited course of the river Niagara, and of the interruption which its waters have to surmount, in falling from the level of one vast lake, to the lower level of another, at but a few miles distance, *sawing its way through the resisting rocks, with a rapidity almost visible*, that the idea first occurred to me, of the possibility of computing *the time*, as well as the *distance*, through which the operation had already passed, and of thus perhaps attaining *the distinct and definite date of the commencement* of this great mechanical operation. I have to regret that circumstances have hitherto prevented me from personally examining the objects which I am now obliged to describe from the eyes and pens of others; but it is fortunate that the simplicity of their features, and the nearly complete accordance which we find, in the numerous descriptions of this fall, which have been published, enable any one who attentively studies them, to form an adequate conception of the form and progress of the vast operation*.

After what has been already explained in the foregoing chapters, it must be clear to any one who examines the courses of the rivers, on a map of North America, that the whole of that Continent presents a magnificent instance of a dry land, sloping on all sides, to the exact level of the surrounding ocean. The main streams all take their origin in the central summit levels; and, in no other part of the earth, is the beautiful mechanism of valleys more fully displayed, than in the great table lands, drained by the Mississipi and the St. Lawrence, with their innumerable tributaries; each of the latter falling into the principal channel, *at its own proper level*, while those valleys which open into the lakes of that country, uniformly present *the same levels*, and thus bear testimony to the *simultaneous* origin of all these valleys, and to the vast *aqueous* agency which their phenomena so universally bespeak.

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* Little was known of the falls of Niagara, previous to the commencement of the last century. The Americans have a tradition that they were discovered by two of the earliest missionaries, Joseph Price and Henry Wilmington, who had received orders to penetrate into the interior, and who left Boston to visit the great lakes, of which they had heard vague reports from the Indians. The name is an Iroquois word, signifying "*the thunder of waters;*" but, it appears that the Indians were not aware of its existence, until this period, having been deterred from approaching it, by a superstitious dread of the tremendous roar.

In addition to many well-written accounts, we have lately had the advantage of seeing, in London, an extremely clever panoramic view of the Falls, by Mr. Burford.

Mr. Washington Irving, in his Astoria, speaking of the annual floods of the Mississipi and its stupendous system of tributaries, extending, as they do, over almost a fifth part of the continent of North America, and forming, by diluvial valleys, one of the grandest specimens on the globe, of the system of drainage now under our consideration, says: "And here we cannot but pause, to notice the admirable arrangement of nature, by which the annual swellings of the various rivers which empty themselves into the Mississipi, have been made to precede each other, at considerable intervals. Thus, the Red River precedes that of the Arkansas, by a month. The Arkansas also, rising in a much more southern latitude than the Missouri, takes the lead of it, in its annual excess, and its super-abundant waters are disgorged and disposed of, long before the breaking up of the icy barriers of the north; otherwise, did all these mighty streams rise simultaneously, and discharge their vernal floods into the Mississipi, an inundation would be the consequence, that would submerge and devastate all the lower country."—(Vol. I., p. 241.) This writer, who is so familiar with the American rivers, and the boundless prairies of which they form the drainage, gives us, in the same work, an occasional glimpse of the nature of the valleys, sufficient, with the assistance of a good map, to convince us, that the basin of this noble river presents one continued example, on the largest possible scale, of the beautiful arrangements exhibited also by the European rivers, as they have been already described, each tributary joining the main drain, exactly *at its own proper level*, and altogether independent of every other stream. In alluding to the Missouri, he says, " From the summit of a range of bluffs, on the opposite side of the river, they had one of those vast and magnificent prospects which sometimes unfold themselves in these boundless regions. Below them was the valley of the Missouri, *about seven miles in breadth*, clad in the fresh verdure of spring; enamelled with flowers, and interspersed with clumps and groves of noble trees, between which the mighty river poured *its turbulent and turbid stream.* The interior of the country presented a singular scene; the immense waste being broken up, by innumerable *green hills, not above eighty feet in height*, but extremely steep, and acutely pointed at their summits. A long line of *bluffs* extended, for upwards of thirty miles, *parallel to the Missouri*, with a shallow lake stretching along their base, which had evidently once formed a bed of the river." These *bluffs* appear to be such precipitous banks, as have already been described as *heughs*, in the Scottish valleys, and which alternate, from side to side, at every bend of a valley.

In another place, the same writer speaks of a singular hill, on which one of the native chiefs was buried, by his own desire. "It was a hill or promontory, upwards of four hundred feet in height, overlooking a great extent of the Missouri. The river washes the base of the promontory; and after winding and doubling, in many links and mazes, in the plain below, returns to within nine hundred yards of its starting place; so that, after *thirty miles* of labour with sail and oar, the voyager finds himself continually near to this singular promontory, as if spell bound."—(Vol. I., p. 279.)

One more scene may be interesting, and may assist our imperfect ideas of a scale of things, of which a European can form no adequate conception, from any thing presented by river scenery, of the ordinary kind. "The prairies bordering on the river, (Missouri,) were gaily painted with innumerable flowers, exhibiting the motley confusion of colours of a Turkey carpet. The beautiful islands, also, presented the appearance of mingled grove and garden."—"Sometimes, where the river passed between high banks and bluffs, the roads, made by the tramp of buffaloes for many ages, along the face of the heights, looked like so many well-travelled highways. At other places, the banks were banded with great veins of iron ore, laid bare by the abrasion of the river. At one place, the course of the river was nearly in a straight line for about fifteen miles ; *the banks sloped gently to its margin,* without a single tree. Along *each bank,* for the whole of that distance, extended a stripe, one hundred yards in breadth, of a deep rusty brown, indicating an inexhaustible bed of iron. This is one of the mineral magazines, which nature has provided in the heart of this vast realm of fertility, and which, in connection with the immense beds of coal on the same river, seem garnered up, as the elements of the future wealth and power of the mighty West."—(p. 306.)

The absence of *bluffs,* in the whole of this *straight* part of the valley, is highly illustrative of what has been explained as their *cause,* on other rivers, *viz.,* the more violent action of a powerful diluvial drainage, in the act of being rounded off into a different direction*. The perfect *horizontality,* also, of the above bed of iron stone, for so great a distance, is an interesting fact in the geology of that country; and likewise shows, that the valleys of denudation are there, as elsewhere, scooped out of the solid and *undisturbed* mass of strata, in a manner altogether opposed to the theory of *fissures*. Our author seems to entertain the same erroneous idea, with respect to these rivers having worked out, *for themselves*, their own courses, which has been already noticed. If it be any where excusable, it is perhaps in scenes of such vast magnitude as he was describing; and the currents of the American streams, together with their annual *freshes*, or floods, may be well calculated to have a powerful influence on the mind, in judging of this subject. But, even *there*, every thing seems in proportion; and if the stream is gigantic, so also is its valley, and that even to a degree of disproportion, which ought to convince any one, that the waters of *such a stream*, never could have reached to the breadth of *such a valley*.

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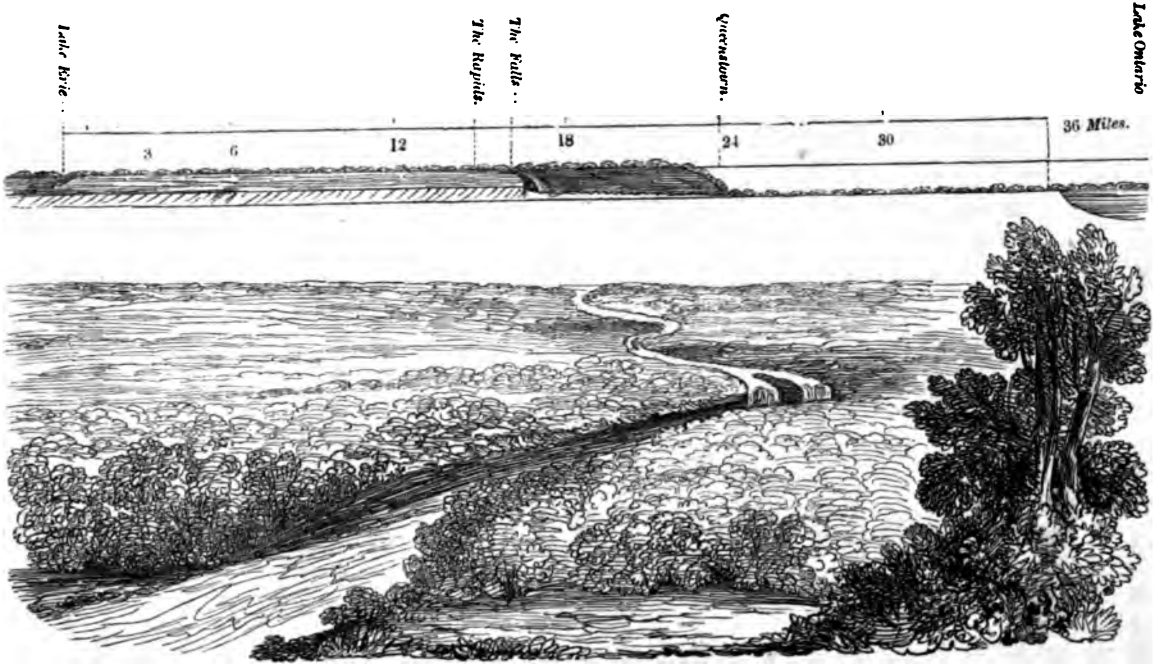
* One bend on the Missouri is called the *Great Bend,* from the river there winding, for about thirty miles, round a circular peninsula, the neck of which, is not above two thousand yards across. We have many such, though on a smaller scale, in our European rivers ; and perhaps no river is more remarkable for such windings, in a rocky district, than the Moselle, which falls into the Rhine at Coblentz.

It is in the central part of the long drain, which afterwards forms the St. Lawrence, that the river Niagara is found. It is at once the shortest, and the fullest, of all known rivers; though it contains, as Captain Hall has remarked, more water than any other river, at the same distance from the sea, it is yet no larger at its mouth, than at its commencement. Its course too, is but thirty-six miles in length, instead of some hundreds, as its fulness would naturally bespeak. This apparent anomaly, is, however, at once explained, when we consider that it forms only the connecting link, between two of the great inland seas of that continent; and that its short and turbulent course, has neither time nor space to acquire nourishment, from subsidiary streams. It is in the course of this immense flow of drainage, that the great Lakes Superior, Michigan, Huron, Erie, and Ontario, occur; and the thirty-six miles of stream, between the two last of these lakes, is known as the river Niagara. It is scarcely necessary to remark, (since the generally navigable nature of all the American rivers, denotes the fact,) that the table lands of that country, are at no great elevation above the ocean. The inclined planes are usually but little sloped; and the *rapids*, on the larger streams, are often occasioned by a very slight deviation from the common line; owing their force and danger, much more to the quantity of the water, than to their real perpendicular height.

Some idea may be formed of the extent of the inland basins of this part of America, when we learn that Lake Superior has a circumference of one thousand, one hundred and fifty-two miles, and a depth, in some places, of nine hundred feet. Lake Huron is eight hundred and twelve miles, in circumference; Lake Michigan, seven hundred and thirteen miles; and Lake Erie, six hundred and fifty-eight miles; the whole comprising a space of *one hundred and fifty thousand square miles!* The elevation of Lake



Section, and Bird's-eye View of Niagara.

Superior above the sea, is only *one thousand and forty-eight feet,* which sufficiently bespeaks the generally level nature of that country.

On this particular line of drainage, of many hundreds of miles in extent, there occurs no material interruption to the regular flow of the waters, except in the spot where the falls are now seen, at Niagara; those of St. Mary, between Lakes Superior and Huron, being rather a succession of rapids, than regular falls. The total distance between Lakes Erie and Ontario, is but thirty-six miles; and as the first seventeen miles, and the last twelve, are of the usual easy slope, and *navigable,* our inquiries, as to the cause and working of the cataract, are confined within the narrow limits of only *seven miles.*

The section, in the upper part of the annexed sketch, will assist the reader in forming a better conception of the relative levels of the two lower lakes, although no attempt can be made, on so small a scale, to give the real proportions, as to depth.

The waters from the immense basins of Lakes Superior, Michigan, Huron, and Erie, have all to pass on, through Lake Ontario, towards their ultimate destination in the sea, in the Gulf of St. Lawrence. But there is a difference of level between the two last lakes, amounting to *two hundred and ninety feet,* as appears by the lately constructed lockages, on the Erie Canal. This difference, the immense body of waters has to surmount; and as an examination of the generally simple forms of that country, ought to point out the *cause*, and to define the exact spot, of the *commencement* of the action, we must now borrow, from the writings of others, such descriptions as may complete the picture, and lead us to the more important branch of the subject relating to the *period*, at which this vast machine was, *for the first time*, set in motion.

Mr. Burford, who lately painted the panorama of the Falls, which was exhibited in London, says, "In the early part of its course, the river is broad and tranquil, and presents a scene of the most profound repose, its waters being nearly level with its shores, and a beautiful island, dividing it into two streams, for a considerable distance. At Chippawa, about two miles above the Falls, where the navigation ends, a considerable current is perceptible, and the glassy smoothness is disturbed by slight ripples. From this place the shores contract considerably, and the bed of the river begins to slope; the water, shortly after, becomes much agitated, and the magnificent *rapids* commence; rock after rock chafes the stream, which becomes perfectly white, and rushes with frightful velocity to the edge of the precipice, over which it plunges in an unexampled volume, and with terrific impetuosity, being unquestionably the greatest mass of water that is poured over any fall, either in the Old or New world; being computed at more than *one hundred millions of tons, per hour*. However great this quantity may seem, yet it is probably not overrated; for it must be remembered that the four great lakes, (which, from their size, might more properly be termed inland seas,) with the numerous and large rivers which flow into them, covering a surface of one hundred and fifty thousand square miles, and containing nearly one half of the fresh waters on the face of the globe, have but this one outlet, for their superfluous waters."

Captain B. Hall, in describing the same scene, says, "In the first part of the course of the Niagara, this river slips quietly along out of Lake Erie, *nearly at the level of the surrounding flat country*; so nearly so, indeed, that if, by any of those causes which swell other rivers, but have no effect here, the Niagara were to rise eight or ten feet perpendicularly, the adjacent portion of Upper Canada on the West, and the State of New York on the East, would be completely laid under water. After the river passes over the Falls, however, its character is immediately and completely changed. It then runs *furiously* along the bottom of a deep wall-sided valley, or huge trench, which seems to have been cut into the *horizontal* strata of the limestone rock, by the continued action of the stream, during the lapse of ages. The cliffs on each side, are, in most places, nearly perpendicular, without any interval being left between them and the river, or any rounding of the edges at the top; and a *rent* would seem a more appropriate term than a valley." I may here observe, that a *trough* would perhaps be a more suitable term than either, as bespeaking the result of continued mechanical action. A *rent* seems to imply the sudden effect of some violent convulsion of nature. This idea, which some might be disposed to entertain, is disproved, by the very same conclusive evidence which we have already adduced, in refuting the idea of a similar origin with regard to valleys, *viz.* by the perfect order and correspondence in the horizontal strata, on each side. Mr. Robert Bakewell has also made the same remark, in a scientific and excellent description of the Falls, which appeared in Loudon's Magazine of Natural History, in 1830. He says, "It may, perhaps, be said, that this deep channel is a *rent*, made by an earthquake. This supposition might avail, if the strata were deranged; but the reverse is the fact: *the strata are parallel, and on the same level, on each side;* and they bear evident marks of the action *of some powerful instrument* having cut through them, in a perpendicular direction; that instrument was water." Captain Hall thus continues, "Above the falls, therefore, that is, between them and Lake Erie, there is literally no valley at all; as the river flows *with a gentle current,* and almost flush, as seamen call it, or level with its banks; while below the cataract, the bed of the river lies so deep in the earth, that a stranger, unprepared for these peculiarities, is not aware of there being any break in the ground at all, till he comes within a few yards of the very edge of the precipice."

We may now follow, in its natural order, the course of the river, and remark such points as bear upon the general subject of this treatise. I shall continue to quote from Mr. Bakewell's paper, from Captain Hall's work on America, and from Lieber's "Stranger in America," as expressing the views of cool and scientific observers, having no bias whatever, towards the objects of our present research.

It appears, then, that from Lake Erie, down wards the waters are nearly flush with the surrounding flat country for seventeen miles, and several large islands divide the gently flowing stream. At about half a mile, or a little more, above the actual cataract, the rapids begin, having a fall of fifty-eight feet. From the Table Rock, (or rather from where it once stood, for it fell, with a noise like thunder, in the spring of 1835,) the whole scene of the cataract bursts at once upon the view. "We here," says Mr. Bakewell, "stood upon a level with the top of the fall. The loud, solemn, all-pervading roar of the waters is indescribably awful. The great commotion of waters, at the base, is concealed by thick clouds of mist, which, on ascending to a certain height, are borne away by the winds. The water, from violent agitation, is perfectly white, for some distance below the falls, and tilts up and down like a little sea, producing a thick cream-coloured foam, which is seen floating down the stream in large beds. The sublimity of the scene cannot be exceeded. We find ourselves suddenly in the presence of a superior power; and feel an impressive consciousness of our own nothingness. This fall, (which from its concave form is called the Horse-shoe Fall,) is *six hundred yards wide*, and *one hundred and fifty-eight feet perpendicular, in height*. The descent of the rapids, immediately above the falls, is fifty-eight feet, making the whole, *two hundred and sixteen feet*. Goat Island, which divides the American from the Canada Falls, presents a bare face of perpendicular rock, which extends about five hundred yards north and south. The American Falls are thus a little lower down the stream, and are about *two hundred yards wide*, and *one hundred and sixty-four feet in perpendicular height*, or six feet higher than the Horse-shoe Fall."—" The only perceptible variation observed in the quantity of water at the falls, during the year, is when a strong South West wind sweeps over the wide expanse of Lake Erie, driving its waters into the mouth of the river." We may form some faint conception of the magnitude of this natural *saw-mill*, when we learn, that Dr. Dwight estimates the quantity of water which passes, *hourly*, at 102,093,750 *tons;* Mr. Darby, at 1,672,704,000 *cubic feet;* Mr. Picken, at 18,524,000 cubic feet, *per minute!* These calculations are the results of careful measurements of the depth and velocity of the river, near Blackrock, where it issues from Lake Erie. Every observer is struck with the *calm* and *solemn* manner in which the ceaseless waters are precipitated into the abyss. Lieber says, " None of the three falls *tumble;* they *leap*. The terror of Niagara is like the fury of a lion, who leaps with grace upon his prey." Another writer says, "How slowly and solemnly the waters *drop* into the abyss! Nothing is so striking as the deliberateness with which they take the tremendous plunge. All is hurry, and foam, and fret, till they reach the smooth limits of the curve: the laws of gravitation then seem suspended; they appear to pause; and then take the awful leap with becoming dignity."

Let us now observe the manner in which this natural *saw-mill* operates upon the rocks, to which its force is applied. Captain Hall was led to make a minute scrutiny of the sides of the rocky trough, in order to form some conception of the *possibility* of what he found was the prevailing opinion of the natives on the spot, as to the seven miles from Queenstown upwards, having been gradually cut through, *by the ceaseless action of the cataract.* He describes the rock as calcareous, and of two degrees of hardness. First, there is a thick covering of diluvium, common to the whole surrounding country; then come about seventy feet of a rock of considerable hardness, and in strata quite horizontal. Below this, however, the solid stone ceases; and is succeeded by about eighty feet of a soft and crumbling shale; and this shale, being violently acted upon by the currents both of air and of water, is rapidly excavated; and the upper beds of harder materials, being thus left without support, that species of *gallery* is formed, *behind* the falls, into which more daring travellers venture, to the distance of about one hundred and fifty feet.

Mr. Bakewell gives the following account of his entry into this gallery. "We took off our clothes at a hut, built at the bottom of the staircase; and equipped ourselves with strong shoes, large loose cloaks, and strong, white-painted, and broad brimmed hats. We had not proceeded far, over the loose and slippery stones, before the guide stopped to wash his head at a sulphur spring, which came down in large drops; what its virtues were I did not inquire. On turning a sharp angle of the rock, a sudden gust of wind met us, coming from the hollow passage, between the falls and the rock, which drove the spray directly in our faces, with such force, that, in an instant, we were wet through. When in the midst of this shower-bath, the shock took away my breath; I turned back, and scrambled over the loose stones, to escape the conflict. The guide soon followed, and assuring me that I had passed the worst part, I made a second attempt; but so wild and disordered was my imagination with the novelty of my situation, that when I had reached half way, I could bear it no longer, and hurried out much faster than I entered, having taken but a hasty glance of the great sheet of water over my head."

Captain Hall's account of this singular cavity is more satisfactory. "I visited," says he, "on three different occasions, the extraordinary cave, between the cascade and the face of the overhanging cliff; first, from mere curiosity; again, to try some experiments with the barometer; and lastly, in company with a friend, purely on account of the excitement which I found such a strange combination of circumstances produces. We reached a spot, one hundred and fifty-three feet from the outside, or entrance, by the assistance of a guide, who makes a handsome livelihood by this amphibious pilotage. There was a tolerably good, green sort of a light, within this singular cavern; but the currents of air blew us, first in one direction, and then in another, with such alarming violence, that I thought, at first, we should be fairly carried off our feet, and jerked into the roaring cauldron beneath. This tempest, however, was not nearly so great an inconvenience, as the unceasing deluges of water driven against us. Fortunately, the direction of this gale is always more or less *upwards*, from the pool below, right against the face of the cliffs; were it otherwise, I fancy it would be impossible to go behind the falls, with any chance of ever coming out again. Even now, there is a great appearance of hazard in the expedition, though experience shows that there is no real danger. Indeed the guide, to re-assure us, and prove the difficulty of the descent, actually leaped downwards, to the distance of five or six yards, from the top of the bank of rubbish, at the base of the cliff, along which the path is formed. The gusts of air rising out of the basin, or pool, below, blew so violently against him, that he easily regained the path."—" The effect of the blast, behind the falls, is just what half a dozen fire engines, playing full in one's face, might produce. Its direction is first one way, then another, crossing and thwarting, in a very confused style; and flinging the water sometimes up, sometimes down, and often whirling it round like smoke, in curls or spirals, to the very top of the cave, a hundred feet above our heads, to the very edge of the precipice, over which we could distinctly see the river projected forwards, and just beginning to curve downwards." The above casual mention of *a high bank of rubbish* at the base of the cliff, gives us, at once, an idea of the incessant destruction of the softer rock, by which the cataract retrogrades. It will easily be understood, that this excavating process is continued, by the force of the currents, until the Table Rock, which is thus undermined, can no longer sustain the immense load of water which presses upon it. It then falls forward into the abyss, with a shock which is often heard and felt at a considerable distance from the Falls, and the same ceaseless process is again begun. The well-known Table Rock, which for years formed the best station from whence to view the scene, projected, in this manner, in the form of a shelf, and was one hundred and sixty-three feet above the pool below. It gave way, however, in 1835. It had long been traversed by considerable seams and fissures; and a great slip fell from the lower part of it, with a tremendous crash, in July

1828. This mass was one hundred and sixty feet in length, and from thirty to forty in breadth. It happily fell during the night, otherwise many lives might have been lost, as the pathway to the guide's house passed over it. It is thus that we may account for the minor varieties which are found in the descriptions of travellers, even within the last twenty years. "The epithet of Horse-shoe," says a recent traveller, "is no longer applicable to the Canadian fall. In the progress of those changes which are continually taking place, from the attrition of the cataract, it has assumed a form which I should describe as that of a semihexagon*." The author of Transatlantic Sketches says, "The American fall seems fast assuming the horse-shoe form. In standing under the falls, one constantly hears the sound of falling rocks amidst the awful roar of the cataract†."

It thus appears to be, on all hands, admitted, that the rate of destructive action on the rock, at this fall, is extremely rapid; and, in this respect, it differs widely from almost every other cataract. We can now easily perceive the distinction between the Falls of Niagara and that of the Rhine, the latter acting on one of the hardest and most compact lithographic limestones, with a force incomparably smaller. But even at Niagara, it seems certain that, to the softness of the strata of shale below, is chiefly due the rapidity of this retrograde action. Captain Hall says, " In the course of our investigations, we met a gentleman who had resided for the last thirty-six years in this neighbourhood. He told us that the Great Horse-shoe Fall had, within his memory, *gone back forty or fifty yards;* that is to say, the edge, or arch of the rock, over which the water pours, had broken down, from time to time, to that extent. This account was corroborated by that of another gentleman, who had been resident on the spot for forty years.

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* *Men and Manners in America*, Vol. II., p. 320.

† In the summer of 1827, a schooner, called the *Michigan*, with a number of animals inhumanly confined on her deck, was towed to the margin of the rapids, and abandoned to her fate. She passed the first fall of the rapids in safety, but struck a rock at the second, and lost her mast: there she remained an instant, until the current turned her round, and bore her away. A bear here leaped overboard, and swam on shore. She then filled, and sunk, so that only her upper works were visible; and she went over the cataract almost without being seen. In a few moments, her fragments, which were broken very small, were seen upon the

" As these statements came from persons of good authority, I was led to examine the geological circumstances more minutely; for I could not conceive it possible that the mere wearing of the waters could perform such rapid changes, upon hard limestone. The explanation is simple, however, when

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basin below. A cat and a goose were the only animals found alive. In October 1829, the schooner *Superior* was towed into the current, and abandoned; but she struck on a rock about the middle of the river, where she remained a considerable time, till broken up by the force of the current.

the nature of the different strata is attended to. In the first place, they are laid *exactly horizontal,* the top stratum being a compact calcareous rock. In the next place, I observed that in proportion as the examination is carried downwards, the strata are found to be *less and less indurated,* till, at the distance of one hundred feet from the top, the rock turns to a sort of loose shale, which crumbles to pieces under the touch; it is rapidly worn away by the action of the violent blasts of wind, rising out of the pool into which this enormous cascade is projected. In process of time, as these lower strata are worn away, the upper part of the rock is left without a foundation. But owing to their tough nature, these strata continue to project a long way over, before they break down. At the time of our visit, the top of the rock overhung the base, between thirty-five and forty feet, thus forming a hollow space, or cave, between the falling waters and the face of the rock." Thus there seems no reason to doubt the rapidity of this natural mechanism, which, at the above rate, amounts to *between three and four feet per annum,* or to an annual average of *three feet four inches.*

Having, therefore, thus acquired some data, on which to form a judgment, we must now follow the line of the torrent, and endeavour, by ascertaining the height of the rocks, and the distance, down to Queenstown, (where the great operation is described as having begun,) to arrive at some idea of the *period* during which this *saw-mill* has been in constant movement: for, as we have already shown, this river, like every other, must have begun *on the very first day* that the table land, over which it now flows, became elevated above those waters, in which the sedimentary and horizontal beds of shale and limestone must necessarily have been deposited; and when the great beds of diluvium, which cover the general face of the table land, were left upon it. We can, by no argument, escape, in this remarkable instance, from *a certain definite period of commencement*, however remote or recent that period may prove to be.

Captain Hall's description of the country between Lake Ontario and the heights of Queenstown, is as follows: "On our way to the Falls, we had one view, and that merely a glance, of Lake Ontario, through a wide opening in the trees, on the top of a rising ground. That enormous sheet of water which is one hundred and seventy miles long, had none of those appearances of a lake, familiar, as such, to our eyes. It had the same deep blue tint as the ocean, and possessed all the appearance of boundless extent. Between the spot where we stood, and the south-western margin of the lake, there lay a belt *of flat country*, eight or ten miles in breadth, matted thickly with the untouched forest, and nearly as striking as the grand lake itself. This wooded ground was *quite smooth, and nearly horizontal.* In casting the eye over this vast extent of forest, *not the* *slightest inequality of surface could be distinguished.* The foliage, indeed, appeared to cling to the ground, like a rich mottled carpet."

Mr. Bakewell says, "Proceeding northward from the falls of Niagara, the road continues for seven miles, on the same table land, which is nearly on a level with Lake Erie; when, at length, the country *suddenly sinks down to a lower plain,* spreading to the shores of Lake Ontario. Descending to this plain, I came to the small village of Queenstown, situated near the banks of the river, where I was agreeably surprised, on seeing the *abrupt termination* of the opening or channel, through which the river flows, after its descent at Niagara.

"It is very remarkable that the river does not enlarge, on escaping from its narrow bounds; continuing of the same width, with little variation, until it is lost in the waters of Lake Ontario. The current is very rapid, compared with what it is immediately below the Falls. The ferryman, in crossing with his boat, was obliged to ascend a considerable distance by the bank, and then glide down the current, towards the opposite side. The waters of Lakes Superior, Michigan, Huron, and Erie, all pass through this channel, which gives a peculiar interest to the place, when taken in connection with the appearance of the chasm, from whence these waters issue."

We learn, from these very clear descriptions, that that part of America is composed of two great table lands, the difference in the level of which, from the surface of Lake Erie, to that of Lake Ontario, has lately been proved, Mr. Bakewell tells us, by the lockages on the canal, to be two hundred and ninety feet. Now, as the rapids above the Falls are fifty-eight feet, and the Horse-shoe Fall itself one hundred and fifty-eight high, if we allow four feet of fall, for the slight current above the rapids, to Lake Erie, we have two hundred and twenty feet of fall, from that lake to the base of the cataract. Admitting, then, a fall of about six feet, for the twelve navigable miles, from Queenstown down to Lake Ontario, we have yet left, a fall of not less than *sixty-four feet*, in the seven miles of passage through the trough, from the Falls, to the opening at Queenstown. Thus

	Miles Dist.		*Feet Fall.*
From Lake Erie to the top of the rapids.	16½	*say*	4
The rapids	½		58
The Fall			158
The trough	7	*say*	64
From Queenstown to Lake Ontario	12	*say*	6
Miles	36	Feet	290

Former accounts give a greater total difference between the levels of the two lakes, some making it three hundred and thirty feet, others three hundred and thirty-four. But as Mr. Bakewell mentions the definite measurements and levellings on the Erie canal, we can have the less hesitation in taking his statement as conclusive authority. Should subsequent information, however, prove that he was mistaken, in thus differing from former writers, the forty feet, to which that difference amounts, must be placed to the account of the slope in the deep trough below the Fall, which, in this case, will have a fall of about *one hundred feet in seven miles*, instead of only sixty-four, as above stated*.

Mr. Bakewell thus proceeds: "The height of the chasm in the solid rock, (independent of the receding diluvial soil,) is *about* two hundred feet to the plain; its width at the opening is *perhaps* four hundred yards." This is not such definite information as we could wish, for the purposes of correct com-

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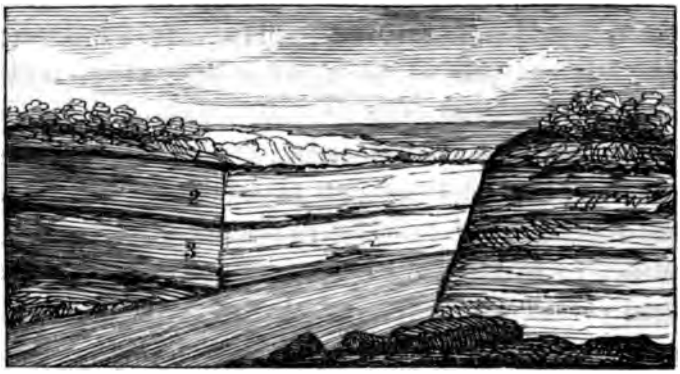
* In a short and well written account of Niagara, forming the descriptive preface to Mr. Burford's Panoramic View of the Falls, lately exhibited in London, the writer says, "The distance from lake to lake is thirty-three miles, and the breadth of the river varies from half a mile, to two miles. In this distance, the water sustains a fall of three hundred and twenty-two feet, thus calculated:"—

" Between Lake Erie and the rapids	15 feet.
In the rapids	51
At the Fall	150
Remainder	106
Feet	322."

Thus we find varieties in the accounts even of the fall itself, as well as of the distance from lake to lake. I have preferred following Mr. Bakewell's account, as the most recent, and apparently the most carefully and scientifically written. Captain Hall states the total difference of level to be three hundred and thirty feet, but he does not say on what authority his statement is founded.

putation, so desirable in this instance; but its appearance, at the mouth, he represents in a vignette, thus.



1. *The receding diluvial covering.* 2. *The harder rock.* 3. *The softer shale.*

It must be explained, however, that the sloping face of the upper table land, which thus presents its front to the plains of Lake Ontario, and extends across the opening, as seen in the sketch, is by no means *a precipitous cliff*, as here represented. On the contrary, it has an easy slope, and is covered with soil, sustaining a rich vegetation of woods and herbage (as in the bird's eye view, at page 167); it is here represented bare, and cut sharp, merely to show the section of the constituent rocks. Of this section, Mr. Bakewell gives us the following very clear description: "Before adverting to the causes which have combined to effect the excavation of the chasm, seven miles in length, and two hundred feet in depth, it may be proper to say something of the strata which form the table land, in which the excavation is made.

The diluvial sand, *in which immense boulders are embedded*, varies in thickness, *from ten to one hundred and forty feet;* under this, is a bed of hard limestone, containing a few imperfect organic remains: this stratum is about *ninety feet* in thickness; and it extends nearly in a horizontal direction over the country, *and forms the bed of the river, above the Falls.* This limestone rests on a bed of loose shale rock, nearly of the same thickness: it is *exceedingly fragile,* and crumbles into small pieces on being removed from its native bed; the shale also contains some pieces of dark argillaceous limestone. Had all the strata been of *solid* limestone, there is great reason to believe that the erosive action of the water would have been very slow; and many generations might have passed away, without any *sensible* change taking place; but the vast mass of waters, breaking, with inconceivable force, on the softer shale, which forms the base of the hard rock, the foundation is thus undermined, and the latter breaks down, in great masses, for want of support."—"The distance from the opening near Queenstown, up to the Falls, is seven miles, or twelve thousand, three hundred and twenty yards, which gives, (if Mr. Forsythe's statement be allowed to be correct, of the Falls having receded *fifty yards*, or *one hundred and fifty feet, in the last forty years,)* a period of nine thousand, eight hundred, and fifty-six years, for the time in which they have retrograded to where they now are. As we cannot be certain, however, that the rocks were equally hard, in every part of this distance, the process of disintegration may have been quicker, and the period consequently shorter." Mr. Bakewell then goes into some remarks on the greater quantity of the waters of this river, in former times, than at present, as he conceives is shown by the *sand beds* and *boulders*, over the face of the surrounding country; in depositing which, " the waters must have flowed," says he, " at a higher level." I shall not enter upon his views on this part of the question, having already, I trust, adduced sufficient proof of the former existence of higher waters, though not such *merely atmospheric* waters as now flow in this, and all other rivers. We may now turn our attention to the seven miles of channel between the Falls and Queenstown, within which short limits, the question, as to *time*, is strictly confined.

It has been said above, that the Falls are now retrograding at the rate of *forty or fifty yards, in forty years.* This, it must be admitted, is but an indefinite datum, on which to calculate so important a question : for though the loss may be *less*, it is fully as likely to be *more;* and even one foot *per annum*, more or less, makes a vast difference in our calculations, during some thousands of years. Thus, if we take the loss at the higher number, *viz.* fifty yards, in forty years, it gives a period of nine thousand, eight hundred, and fifty-six years, to cut through the seven miles; if, on the other hand, we take the lower number, of only forty yards in the same time, it speaks to a period of twelve thousand, three hundred, and twenty years: by preferring the medium, or forty-five yards, we have a period of eleven thousand and eighty-eight years, for the execution of the work, from *the first day* of its commencement to the present time, on the supposition that the operation has always proceeded *at the same rate as during the last forty years.* No writer, indeed, who touches on this part of the subject, has calculated on a longer period than about ten thousand years: and when we consider, on the one hand, the unbounded periods on which geologists usually calculate, in which ten thousand years appear as nothing; and, on the other, the fact which cannot but be admitted, that *as the work at Niagara must have been begun, the very first day the river began to flow; and that, before that period, there was no river, nor any of its present innumerable tributaries*, and that, consequently, the American continent *did not exist*, as it now does; X True when we view the question in this, its true light, we cannot but admit, that the power thus afforded us, of distinctly attaining, even the date of ten or eleven thousand years, as the origin of so large a portion of the dry land, altogether exempt from volcanic action, is most interesting and important, in every point of view. But even this vague conclusion arises from the supposition, that the work, as now seen in progress, has never been more rapid than at the present time, even admitting the correctness of

Illinois Prairie shows once bottom of
lake or ocean – broke through
below St Louis & Niagara

Mr. Forsythe's statement. Thus, making the fullest allowances, we cannot trace the existing state of things, on the American continent, further back than *ten or twelve thousand years.*

At the period of commencement, then, we find that Lake Erie, (and of course all the higher lakes,) *was full, and first began to overflow;* the superfluous waters, arising, as they now do, from the atmosphere, sought the level of the sea, as in all other lands. They found, as those at Schaffhausen also did, an inequality in the inclined plane *that had been previously prepared for them,* by that aqueous agent which scooped out the dry valleys, and which covered the surface of the table lands of both Erie and Ontario, with what Mr. Bakewell describes as "diluvial sand, containing immense boulders." However difficult it may be to account for so sudden a change of level, between two table lands, of such vast extent as those around Lakes Erie and Ontario, we can readily understand, on the principle already explained, with regard to the origin of valleys, by a descending power of waters in search of a new level, that, in a district so little elevated above what was to be that new level, the hard limestone rock above described, had sufficient strength to resist a flow that must there have been but feeble. Following, then, the course of the new river, *on the first day of its overflowing the basin of Lake Erie,* we conclude, that the mass of waters must have passed over the rapidly inclined slope of the country, at Queenstown, which slope must, of course, have been nearly in the same form in which it is still seen, stretching *laterally* across the country, at right angles with the course of the river. The diluvium, in its course, being instantly swept away by the river, the horizontal strata of the hard rock below, began to feel the friction of the torrent. Such a mass of waters could not flow over a slope of even a few feet, without producing an instant derangement; how much more, then, in passing over a sloping declivity of *two hundred feet!* It consequently *ploughed* into the vale below, and then continued its gradually tranquillizing course downwards, towards the basin of Ontario, on its way to the still lower levels in the Gulf of St. Lawrence. But the *ploughing*, or rather *sawing* process, then begun, could not cease; and it has been, accordingly, continued backwards, *from that day, to the present time.*

Having thus, at length, satisfactorily attained at least *one* firm resting place, in the obscure and indefinite periods of geological chronology, we may now return to a closer examination of the evidences presented by the lower parts of this section; and, as we cannot extend the given period, *beyond* ten or twelve thousand years, we may chance to find that even a considerably shorter period may have been fully sufficient, for the completion of the whole task.

And first, we learn from Mr. Bakewell, that the diluvial covering of that country varies *from ten to one hundred and forty feet in depth.* We do not learn from his excellent paper on Niagara, how he acquired this last amount; but if it is given from an examination of the sections presented in the sides of the trench itself, it will, in some places, reduce the amount of *solid rock* to be cut, greatly below what is seen at the present Falls, and consequently lead to a proportionate deduction from the above period of *time*. Leaving this point, however, to be decided by future and more minute investigation, we must next turn our attention to the width of *space*, over which the present friction of the torrent is spread, compared with that of the trench, which has been already cut. We find, then, that the width of the Horse-shoe Fall alone, is *six hundred yards*. To this must be added, that of the American Fall, *viz.*, *two hundred yards*, amounting to a total width of *eight hundred yards*, (or nearly half a mile,) over the whole of which space, the waters now act, (according to Mr. Forsythe's testimony,) at the rate of *between three and four feet per annum*. But when we turn to the opening of the chasm, near Queenstown, we are struck with the fact mentioned by Mr. Bakewell, that the width there, *instead of eight hundred yards, is only about four hundred*. We instantly go back, in order to discover what is the cause of this marked difference; and we find that the river, at the present Falls, is spread out nearly to its utmost possible width, owing to the position of Goat Island, which divides the waters into two channels, five hundred yards distant from each other, at the extremities of which, the two falls are seen. By this interruption, or by some slight inequality of the ground, the course of the stream makes here a considerable bend; and, at a very short distance below the ferry, the channel becomes much reduced in width, *nor does it any where afterwards amount to more than a half of what it is at the present Falls.* Here is indeed a point of evidence on which we cannot hesitate, and one which imperatively leads us to a great reduction in the period of the operation; for the question now becomes reduced to this—"If a given mechanic force will cut through a resisting body, *of seven miles long, and* EIGHT *hundred yards wide, by two hundred feet in depth, in ten thousand years,* what time will be required for *the same mechanic force* to cut through a similar body, *of the same length and depth, but only* FOUR *hundred yards in width?*"

Important as is this result, in ascertaining the true age of the river Niagara, I am inclined to suppose, from some vague and contradictory points in our evidence, as to the real *width* of the chasm, below the Falls, that future investigation will reduce even the above four hundred yards, given by Mr. Bakewell, to a space considerably less, and thus strengthen in proportion, our present conclusion. Most observers have been struck with the great difference in the width of the river, *at* the Falls, and *below* them, though I have not found the widths, in the trench, stated, except in the quotation already given from

of Course, we have to reduce every thing
to suit your purpose of fallacies

Mr. Bakewell's paper. The author of the *Principles of Geology*, reduces it to *one hundred and sixty yards* in breadth. He says, "The waters which expand at the Falls, where they are divided by the island, are contracted again, after their union, into a stream *not more than one hundred and sixty yards wide.*" He likewise fully admits the recession of the Falls, going on the same evidences and authorities which I have quoted. He also saw, however, the probable necessity of reducing the period of its supposed action. "If the ratio," says he, "of recession, had *never exceeded* fifty yards in forty years, it must have required nearly ten thousand years for the excavation of the ravine; but no probable conjecture can be offered as to the quantity of time consumed in such an operation, because the retrograde movement *may have been much more rapid,* when the whole current was confined within a space *not exceeding a fourth or fifth of that which the Falls now occupy.*"—*Principles of Geology,* Vol. I., p. 208.

It is of some importance to obtain, from so strong an advocate *of slow and ceaseless natural action,* in producing all the phenomena of geology, in boundless periods of time, so remarkable an admission as the *commencement* of this great operation, at a period not more remote than *ten thousand years;* and the high probability, (he might have said the *certainty,*) of its having been much more recent. No attempt is made to *increase* the period, as every fact obviously tends the other way. It is only remarkable that so acute a reasoner should not have gone a *little further back* in his speculations, respecting these Falls, and informed us what was the probable state of things on that continent, *a short time previous to the first descent of these waters*, at Queenstown. It is unfortunate for the volcanic theories, which he so unsparingly applies, that there is nothing in that wide district of America, to induce us to attribute to this cause, the extensive disturbance which must have occurred, when the river Niagara *first began to flow;* and yet, deprived of volcanic agency, we have no other *natural* power to apply to the vast basin of the St. Lawrence, by which it could have been raised so suddenly, as to occasion the evidently sudden and well defined *commencement* at Queenstown, of this now ceaseless process.

We cannot calculate, (taking the laws of nature for our guide,) on the waters of the river having ever been *less* in quantity than they now are. Subsequent examination may perhaps show, that, in some places, the solid resisting mass has either been less deep or less broad, than the two hundred feet, and the four hundred yards above described; if such should prove to be the case, a still further allowance must, of course, be made, in reducing the *period* of its action. But setting aside, for the present, these minutiæ, if we are to believe, with Mr. Bakewell, that the huge body of water was confined to a space of *only four hundred yards*, throughout six miles of its retrograde action, while, during the last mile, or half mile, *it is spread over eight hundred yards*, and is, even then, cutting at the rate of between *three and four feet per annum*, we are imperatively called upon to conclude that the ratio of its action must formerly have been *double* what it is now, and *thus to reduce the above period, from ten or eleven thousand years, to about one half that time.* [illegible]

Nearer to the truth than this, however, we cannot at present come, but by the establishment of such exact marks and measurements at the present site of the Falls, as shall enable future inquirers to arrive at more definite data on which to calculate, we cannot doubt that this great natural *index* is capable of conducting us to within a few hundred years, less or more, of the period when the immense basin, drained by this channel, *first became dry land*, and *began* to discharge its rivers at the common level of the ocean. If such is the result, with regard to this particular basin and drainage, we are led, by fair analogy, to the same result, with regard to all other similar basins, though deficient in such indexes. But much might still be done, even at the present day, towards arriving at the true solution of this interesting question. A strict examination should be instituted, under the guidance of skilful geologists or engineers, to ascertain the nature of the rocks, throughout the whole seven miles to Queenstown; and the actual cubic measurements of the channel

&, and therefore, never will get the
truth from such fallacies

already cut; we cannot doubt that the result of the scrutiny would be most interesting to all, and highly important, in a scientific point of view.

In the mean time, it will probably be admitted, that we have gained much, even by the present imperfect examination of the phenomena. Although we have only been able to *approximate* the short period of historical records, yet we have established a period *beyond which we cannot go,* in calculating on the existing face of nature in North America. It is, indeed, a matter of surprise, that, of all the numerous scientific men who have admitted a fixed period, (be it what it may,) for the action at Niagara, no one has ever stepped, even one year, *beyond that period,* and inquired into what must have been the state of things immediately *before* the section at Queenstown was begun.

The final result, then, of our present inquiry, seems to resolve itself into the following positions :—

1st,—That the *stratified* arrangement of the rocks in that part of North America, clearly denotes *a sub-aqueous origin,* as sedimentary deposits. X So [illegible] [illegible] X [illegible] ?

2nd,—That as these strata now constitute a dry land, there must have been *a definite period,* when the change took place from sea to land. If so don't prove [illegible] flood

3rd,—That *on the first day* after this great change took place, *the atmospheric waters,* (from which rivers are solely supplied,) *began to*

+ don't prove flow . as there [illegible] [illegible] for miles, rocks with fossils in open Sea Sediment.

fall, and thus to originate the natural flow of the present rivers. that don't prove flood

4*th*,—That from the day that Lake Erie first overflowed its basin, the river Niagara began to flow over the high inclined slope of the country, at Queenstown; and commenced that violent friction, which, to this day, causes the Falls to retrograde, at the rate of between three and four feet *per annum*. True, What of it

5*th*,—That had all things been in the same relative proportion, as to the acting and resisting forces, in this friction, since that commencement, down to the present time, the distance of seven miles, which have been already cut through, would have required from nine to twelve thousand years: but as the acting force is now spread over *double the space, or more,* to which it was confined during *six* out of the *seven* miles of its course, we are fully justified in reducing the *period* of its action, in a like proportion, by fully one half, and thus computing it at *from four thousand five hundred, to six thousand years.* + in order to

6*th*,—That this period must therefore be regarded as the age, *as a dry land,* of the whole of that part of North America, drained by the river St. Lawrence; and as the valleys, and mode of drainage of the Mississipi, and the other great rivers on that continent, is precisely similar, excepting in the absence of so re-

+ force your argument of flood

markable an index, we are called upon, by all the laws of fair analogy, to attribute *their* origin also, to exactly the same period. of Alluvi

Should we discover, in the course of our examination of geological evidence yet to be adduced, a corresponding result, arising from a totally different line of proof, we shall have occasion again to refer to this singular and interesting instance of natural mechanism; and to draw the attention of the reader, to the important consequences to be deduced, from so singular and obvious a correspondence.

Before we proceed, however, from the consideration of Niagara, to these other parts of our investigation, it may not be either uninteresting, or uninstructive, in a geological point of view, to take a *prospective* glance at the *future course* of this ceaseless action; for it is one to which geologists invariably point, by way of example, in theorizing on the *bursting of lakes*, and on the *local deluges*, which they suppose may have occurred in times past. At the first glance, it is true, it seems very clear that a continuance of the retrogressive process of this cataract, at its present medium rate of *three feet four inches a-year*, would cut through the seventeen miles that remain, up to Lake Erie, in the space of twenty-six thousand, nine hundred, and twenty-eight years; and if we suppose, with these geologists, the *sudden* drainage of all these lakes, (a fact which they assume as inevitable, in due time,) we cannot doubt that a very dreadful deluge would overwhelm a vast extent of the lower country. Such is the natural idea which first occurs to the mind. But a little examination into the real facts of the case, *at Niagara, and below it,* will show that this is a most delusive theory, and that there is, in fact, no reasonable prospect of the drainage being thus effected at all, and most certainly ~~not~~ *suddenly*. In order to perceive this, we have only to reflect that the cataract does not now cut down the resisting rock *to the lowest possible level,* but that, on the contrary, the bottom of the seven miles of trench, already cut by the stream, instead of being like that of a canal, has a slope of not less than *sixty-four feet*, and some authors say, nearly a hundred. The nature of this action, then, is, (like that already described at Schaffhausen,) to convert what was originally *a sudden fall,* into a long and sloping *rapid, with a fall of rather more than nine feet per mile.* Of all the descriptions of Niagara, Captain Hall's is the only one that I have seen, which gives any account of the state of the current in this trench. He says, " The river, at the place where we first saw it, four miles below the Falls, instead of slipping along quietly, finds its way *with great impetuosity,* towards Lake Ontario, *over a steep rocky bed,* so as to form one of the most formidable of those well-known torrents, called *rapids,* this particular one being called, *par excellence,* the *Devil's Hole.*"

Now, we have a right to assume, that what has ╳ occurred, will occur again; particularly in a case of

But suppose no general flood has
occurred [illegible] days not again
a [illegible]) flood shall occur

this sort, where the phenomena are all regular, and the country nearly horizontal, from Queenstown heights to Lake Erie. If, then, there is a fall of sixty-four feet, or upwards, in the seven miles already cut, we may calculate on a further slope, at the same degree of inclination, *of one hundred and fifty-three feet, in the remaining seventeen miles.* This amount being deducted from the total fall, from Lake Erie to the present base of the Cataract, *viz.* two hundred and twenty feet, (as shown at page 182,) there remain but *sixty-seven feet* of drainage, which could possibly be effected in Lake Erie, sufficient, it is true, to cause a considerable flood, if it occurred *suddenly*, which, however, it could not do; it would even be sufficient to lay it nearly dry, if Captain Hall's account of its depth be correct. He says, "Lake Erie is not above ten or twelve fathoms deep," (sixty or seventy feet,) "and is frozen over every season: but Lake Ontario is so deep, that ice never forms upon it."

Thus we find, that the *possible* amount of drainage is much smaller than is usually supposed; for, when we speak generally, of one lake being three hundred feet lower than another, and that an action is now going on, to cut down that level, we at once imagine three hundred feet of water, let out *suddenly*, from the upper lake. But there is another, and still stronger circumstances in this case, which must, in time, put a complete check to the present rapid retrogressive action of the cataract. We are told by all writers that the rocks of that district consist of two beds, completely horizontal, the higher bed being hard and very compact, and the lower as soft and friable. The difference in the consistency of these, is the obvious *cause* of so rapid a decay; and, as Mr. Bakewell has observed, had it not been for the softness of the lower rock, the Fall of Niagara might still have been near Queenstown. The upper bed of hard limestone is described as being about seventy or eighty feet thick, *and as forming the plain towards Lake Erie;* it is evident, then, that by the rapid slope *upwards*, which is left by the river, below its fall, the eighty or eighty-five feet of soft shale, which now form the remainder of the rock at the Fall, will (*at nine feet per mile,*) be entirely freed from the action of the cataract, *in about nine miles more;* and as the river will then fall over the harder rock *alone*, the site of the cataract will there become more stationary, and the action of the stream will assume the slower and more common character of other water-falls. This diminishing effect will also be extremely gradual; and as that portion of the soft shale on which the river acts, will, at every mile, *become nine feet thinner*, we can no longer calculate on such a rate of action for the future, as has occurred in past times.

Here, then, we find a complete check put to the theory of the speedy drainage of the upper lakes of North America: for, if the first seven miles have been executed in four or five thousand years, the next seven must require a much longer period, as the action must gradually become nearly imperceptible towards their upper extremity. Of the time necessary for the remaining section of eight or nine miles, to be cut through *the solid limestone alone*, we can form no sort of conception, except that it will be immense: and being thus deprived of the only known instance of a calculable natural section, pointing to the *bursting of lakes*, we may be excused for regarding this part of the theory of geologists, as altogether visionary and unsound.

But let us even anticipate events, and advance, in idea, to the period when the cataract shall have reached *within half a mile of Lake Erie*, and when, according to the theory of *bursting*, we might yearly expect the recurrence of an event, similar to what geologists so commonly suppose the Mosaic Deluge to have been. If the restraining embankment of the waters of Lake Erie consisted of some *soft* material, we might suppose that the vast pressure of its waters would, at length, overpower the yearly reduced resistance, and thus *suddenly* burst out, over the lower districts, like the waters of the Dranse, already alluded to at page 116, when accidentally impeded by a block of *ice* from a glacier. But we are told that the upper bed of *hard limestone* forms the resisting support to Lake Erie; and as we see that the nature of the cataract is, *to prepare for its fall by a rapid* of half a mile or more in length, it is evident that, when the top of the rapid began to reach the lake, the diminution of the waters in the basin would then *very gradually* commence; and long before the cataract could reach the lake, its bed would be greatly drained, or, in the case of this shallow lake, would be already almost dry. The author already quoted, mentions the fact of Lake Erie filling up so fast with sediments, from the numerous rivers which supply it, that " the question arises whether it may not be converted into dry land, before the falls recede so far. In speculating on this contingency, we must not omit," says he, " one important condition of the problem. As the surface of the lake, is contracted in size, the loss of water, by *evaporation*, will diminish; and unless the supply from the rivers shall decrease, in the same ratio, (which seems scarcely probable,) Niagara must augment continually in volume, and by this means, its retrograde movement may hereafter be much accelerated*." I have just shown that certain, and very simple means exist, of checking this retrogressive action; but all these speculations, we are told, may be rendered vain, by " the relative levels of the district being suddenly changed, by some earthquake†." This, it must be admitted, is the simplest method of draining these inland lakes; but as North America has not suffered much, from such convulsions, within the historic periods, we cannot fairly speculate on future changes, from such a cause. We shall, perhaps, be told, that, to this *cause* must be attributed the event which occurred, immediately anterior to the *commencement* of the section at Queenstown. If so, it is a singularity which ought not to escape our especial notice, that the date of this "*earthquake*" should coincide so closely, with that of the great aqueous catastrophe, so clearly described in the Sacred History.

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* *Principles of Geology*, Vol. I., page 209.

† *Ibid*, Vol. I., page 208.

CHAPTER VI.

ON THE ABRADING ACTION OF THE SEA, ON ITS COASTS. DESCRIPTION OF THE ISLE OF SHEPPEY, AND THE ISLE OF THANET, AS MINIATURE MODELS OF ENTIRE CONTINENTS.

Before entering on the examination of the second line of evidence, in the elucidation of our present inquiry, it may not be improper to take a retrospective glance, and to collect, in a few words, the amount of testimony already adduced, and the result of that testimony, in enabling us to form just ideas of what has occurred upon the surface of the earth.

It has been shown that all dry lands, of whatever extent, bear the same general stamp; that they are all, more or less, of a smooth and rounded form; more elevated in their central parts, than towards their edges; and that their slopes universally point, *to the exact level of the surrounding ocean.*

On a more minute examination of these sloping surfaces, we find even the most solid rocks, of every part of the geological series, channelled out in winding grooves, the bottoms of which grooves form inclined planes, over which the superfluous waters from the atmosphere, glide down, on their return to the sea. We have seen that the undisturbed strata, in a large proportion of such valleys, contradict, most decidedly, the opinion of many geologists, that they must have arisen from *fissures*, consequent upon volcanic upheavings. The winding course of these valleys, exhibits precisely such forms as a fluid would naturally take, when passing over a slightly inclined plane of yielding materials; while the abrupt, and gently sloping lands, which *alternate*, with such regularity, at the bends of valleys, bear still clearer testimony to the aqueous agency, by means of which, they appear to have been hollowed out. But when, to these, we add the further conclusive evidence, borne by the *different levels*, at which all the tributary valleys open into those which are immediately below them, in the system; and when we further find, that those valleys which fall into the basins of lakes, instead of exhibiting this remarkable difference, present the *same levels*, both cases exhibiting the very principle which we should, *a priori*, expect to arise, from an aqueous agent; we can no longer hesitate in our conclusions, in favour of such universal agency, in moulding the existing surface into those forms which we now see, in all directions, around us.

With regard to the particular character of that agent, by which all these mouldings have been impressed upon the earth's surface, we have, as yet, offered no evidence, except that it was *a force of* *waters.* But one most important point of *negative* testimony, we do possess, which is in direct refutation of the opinion now so prevalent, that *because* we see rivers follow the common laws of fluids, and thus flow in the deepest parts of those circuitous valleys, that *therefore,* we are to conclude, that such valleys must either have derived their origin from a long continuance of such friction, or been at least rounded off and modified *by it,* from the form of cracks and fissures, originally occasioned by the upheaving power of earthquakes. This idea is conclusively refuted, by the existence of innumerable *dry valleys,* and by others of great extent, in which streams of but trifling size are found; such valleys presenting the very same winding forms, and the same evidence of unity *of origin,* which are seen in those occupied even by the greatest rivers. In the case of those larger rivers, too, instead of finding the size of their valleys diminishing upwards, in proportion to the amount of their waters, we constantly find, in them, as ample and well defined marks of aqueous agency, in their upper, as in their lower parts; and we see these marks, in the form of smooth and circuitous valleys, almost always extending themselves amongst the hills, far above the highest springs.

And with regard to the *period* at which this great aqueous agency ceased to be in force, we have seen that, as all rivers must necessarily have *begun* to flow, *on the very first day that the earth was freed from its* *presence, and that rain fell from the atmosphere*, the subsequent incessant friction of their waters, on such well defined points of opposing rock, as are occasionally found to obstruct their course, must afford a true key to the exact age of such rivers, provided we can establish the original form of the opposing object, and the exact rate at which the abrading power has acted upon it. This, we have seen, is a point of some difficulty, from the general slowness of such process, and the various degrees of power, in the acting and resisting bodies. In Niagara, however, we have found an index, which decidedly points to a certain date, *beyond which we cannot go.* That date, when taken at the very utmost, indicates a period of only ten or eleven thousand years, as the origin of this prodigious flow of waters. But while we thus attain the *maximum* of the possible age of that immense system of drainage, of which Niagara is the only outlet, we find that the erosive powers of that cataract have been more widely spread and dissipated, for the last two or three hundred years, than during the whole previous period of its existence; and we have, therefore, a right to conclude, that, as the *resisting* body has never been harder, while the *acting* body has been of *double force*, from being formerly confined to one-half its present limits, the period of its action must be reduced, in a like ratio, to about one-half of the above time.

Trav

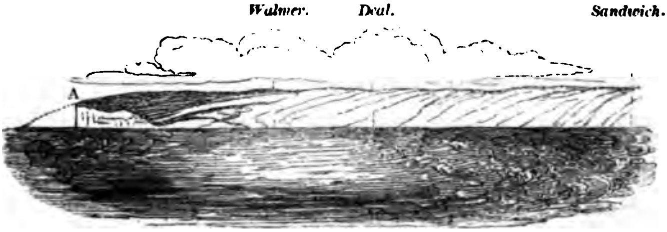
X

Such is the line of reasoning, and such the con-

X Water broke away through lime stone below St Louis
an [illegible], until flowed [illegible]

clusions to which it led, in my own mind, from the gradually expanding point, which originated in the study of the phenomena of Niagara. Not that the whole subject, as now explained, occurred in the order in which I have now thought it expedient to place it before the reader; on the contrary, the arguments arising from valleys, arose subsequently to that which sprung from the phenomena of sea cliffs, which are yet to be described; but I have been anxious to afford to the reader an advantage which I did not myself enjoy; and thus to cut short the circuitous but interesting route, over which it has been necessary for me, cautiously to pick my way.

At the period when the above-described phenomena of Niagara fully occupied my mind, I chanced to be resident at Ramsgate, in the Isle of Thanet, to the south-west of which, extend the chalk downs of Kent, terminating in the South Foreland, where a lofty and perpendicular cliff overhangs the British Channel, and commands a view of great extent both over the Kentish coasts, and those of the opposite continent. As seen from Ramsgate, these downs present the following outline, of a



perfectly smooth and rounded form, *and gradually sloping downwards, towards the exact level of the sea* in every part, except at the imperfect point, where a small portion seems to have been worn off, as at A., in the above sketch. I was instantly struck with the *wedge-shaped* form of this point, and with the smooth and sloping nature of the ground above the point at A.; and as, on a little consideration, I found that other parts of the same downs, about Deal, and further inland, sloped in an *unbroken* line, down to the very level of the sea, in the marshes near Sandwich, I could not help thinking that at A., the smooth slope had also been once continued, until it reached the same general level, where the dotted line now terminates. With this first general impression, I instantly undertook a more minute scrutiny. From the rising grounds, to the westward of Sandwich, I found numerous dry valleys grooved out upon the chalk, and all ending *in an unbroken form,* at the level of the low plain, which there separates the downs from the sea; and these downs presented that universally smooth and undulating form, which every where characterizes the chalk hills. No instance was to be seen of an abrupt and precipitous cliff. Proceeding onwards, in a southerly direction behind Deal, over grounds of a uniform regularity of undulating surface, and mounting to the very summit levels of the chalk ridge, I proceeded directly towards the cliffs which had first attracted my attention, and found that the dry valleys, instead of tending towards the east, and ending in the marshes, as the first had done, now pointed towards the south, in the direction of the sea. I accordingly followed the course of one of these, in the firm assurance, that it also *once* extended to the very same general level as those which I had just seen *still entire;* and when, at length, I reached its abrupt and perpendicular termination, at fifty or a hundred feet above the sea, having still, however, the same smooth forms on the sides, and the same gradually inclined plane at the bottom, which characterized its upper parts, in common with all the other dry valleys of these downs, I felt the fullest conviction that my first impression was well founded; and that we had, in these retrograding sea cliffs, and in the ceaseless waves which evidently give rise to them, another and still clearer instance than Niagara, of *a natural chronological index*, by means of which we might discover, by careful observation and measurements, the exact period at which *the corroding work began.* For as, in the instance of water-falls on rivers, the river could not have existed until the whole lands through which it was to flow, had become freed from a watery covering; and as, from *the very first day*, that friction, occasioned by its rush over a rocky impediment, must have begun, which has ever since been in action; so, in the case of the ceaseless breaking of the waves, upon a shore of a definite and wedge-shaped form, they could not so break, *until that shore was elevated into a dry land;*

but *from that moment, onwards,* they must continue their corroding action, so long as the relative levels of both sea and land remain the same.

Thus a further gleam of light broke in, upon a subject hitherto veiled in nearly utter darkness; and the mind seized with avidity, on the smallest appearance of a solid resting place, in struggling through that "palpable obscure" which shrouds the lofty ascent of theoretical chronology. An immediate inspection of the whole coast of Kent, of Sussex, and of Hampshire, served to bring my first views into a more mature form; and when I extended my researches to the opposite shores of France, from Calais westward, to Boulogne, Dieppe, Havre, and Cherbourg, embracing in this extent, that variety of strata below the chalk, which that coast exhibits, and on *all* of which, similar dry valleys, interrupted only by the sea's action, are to be found, I conceived myself fully justified in regarding these facts in the light of complete mathematical proofs; and in drawing my conclusions from them, precisely as I should do from a simple proposition in Euclid. For it at once became evident, that all lands, at the sea coasts, were originally of the form of *a wedge,* more or less obtuse, according to the angle of the superficial slope of the ground, with the horizontal line of the sea's level; and that this form still remained *perfect,* where free from the corroding friction of the waves; while, in other cases, it was more or less *worn at the point,* in exact proportion to the power of this friction, and to the degree of consistency in the rocks, of which the wedge was composed.

This part of the subject, however, requires a most minute, and attentive consideration; and having found that the phenomena from which our conclusions must be drawn, are *universal*, I shall adopt the plan of confining my illustrations within the limits of the smallest possible districts, in order to obviate that confusion in the mind of the reader, which is too often the consequence of drawing proofs from remote, or little frequented situations. It has already been remarked, that the island of Great Britain forms a complete epitome of an entire continent, with its *central heights*, its extended *plains*, and its *valleys*, whether dry or occupied by rivers, universally sloping, in all directions, to the level of the surrounding sea. That we may, however, still further confine our scale, and study the subject as it were on *models* placed before us on the table, I shall request the attention of the reader to three still smaller districts, one or other of which may probably be known to him, and with all of which, many of my readers must be well acquainted; I mean the Isle of Sheppey, on the southern shore of the Thames, near Sheerness; the Isle of Thanet, in Kent; and the Isle of Wight. In these three islands, we shall find all those geological varieties in the strata, which ought not to be omitted in an inquiry of this nature; and after having there established the principles on which we are to ground our judgment, we may extend our conclusions to every land, where phenomena, precisely similar, are to be found.

We shall begin then, with the small island of Sheppey, as being composed of the blue clay strata, one of the more recent sedimentary deposits, termed Tertiary. This island is of an oblong form, and extends itself along the south side of the estuary of the Thames, lying in the direction of its course, from west to east. Its length is about ten miles, and its breadth not more than about four, in the widest parts, gradually diminishing at both extremities, to two points, on the western of which Sheerness is situated; while the eastern point extends towards Whitstable, on the main land of Kent. There is but one village worthy of the name, on the island, namely Minster, which stands upon the highest point of the long rounded ridge, of which the central part is composed. The interior structure of the whole island consists of the London clay, in strata intersected with beds of sand stone; and a bed of *diluvial sand and gravel,* of various degrees of thickness, according to its situation, is spread indiscriminately over the whole. The height of Minster, above the level of the sea, is about three hundred feet, and this elevation extends to a great part of the oblong central ridge. As seen from Sheerness, the island presents the following outline in its cross section.

The Isle of Sheppey, from the West.

In this view it will be seen, then, that Sheppey is a complete model of what a continent, or larger island, represents. It has its central heights, from whence its valleys tend on every side, to the level of the surrounding sea. It is true, that these, though every where possessing the rounded forms, and the regularly inclined planes of other more important valleys, cannot boast of being occupied by rivers, or even by brooks; for in the dry season, there is nothing more rare, in Sheppey, than abundance of water. But, in other respects, they possess all the characteristics of true valleys, of the greatest size; and the sections on their sides show, that the strata which they intersect from top to bottom of the island, are still in their *undisturbed* horizontal positions, having so remained while these inclined channels, often of considerable depth, were being grooved out upon the surface.

Let us now follow some of these valleys, from their sources to their opening into that level, in which they all have once terminated. Passing, then, from Minster, or any other of the heights to the eastward of it, down the smooth and well defined channels which tend towards the *south*, we find that these all terminate at the same level, in the bed of the Swale, which divides the island from the rest of Kent. They gradually diminish, in the inclination of their planes, and at length totally disappear, upon the surface of the marshes which border the line of this narrow estuary. Returning, now, to the top of the island, and following in like manner, the valleys (*precisely similar in form*,) which are channelled out on its *northern* side, we attain the fullest conviction that they were formed at the very same *time*, and by the very same *cause*, whatever that cause may have been; and we have a full right to conclude, that they also would have formerly led us to a similar *gradual termination*, at the very same level of the sea. But we now find a marked difference in all their terminations. These northern valleys are all cut short in mid-course, by those precipitous cliffs, which border this part of the estuary of the Thames. The sea beats with considerable force upon this shore, during north and north-easterly winds; the consequence is, a rapid destruction of the land, where the clay strata become exposed to the combined action of the sea, and of the winter frosts: land-springs also, burst out from the sand beds; and thus, the foundations being washed away, immense masses of cultivated lands, with their standing crops often undisturbed, slip down to lower levels, on the rugged and broken face, and are eventually washed away by the tide, to make room for other similar land-slips. Thus nothing can be more strongly contrasted, than, on the one hand, the *violent*, and, on the other, the *gentle* terminations of the valleys, on the two sides of this oblong and narrow island; and yet the perfect smoothness and similarity of the two, in their upper parts, plainly bespeak a former similarity *throughout*, which has, however, been interrupted by a violence of which we can see and trace the undisputed progress*.

Now on so small a scale of things as this island presents, and with that regularity and rotundity in its unbroken parts, which we find so universal, it becomes demonstratively certain, that the northern side, if not of the same exact form and inclination as the southern slopes, (which, however, appears most probable,) could not formerly have extended much beyond them; as the course of the valley of the Thames chimes in exactly with the general line of the island, so that but a few hundreds of yards, (probably about three quarters of a mile,) can have been lost, by this continued action of the waves. This loss must have been effected during a certain fixed period. *That period commenced on the first day that the lands of Sheppey, and the sea which surrounds them, became fixed at their present relative levels.* The valleys (which naturally terminate at the level of the sea,) must then all have been *complete*, both on the *sides* and on the narrow *extremities* of the island. On three of these they still remain entire, simply because they have been protected, by their position, from the sea's incessant action; while on the fourth alone, they have been cut short, and from a directly opposite cause. These facts, then, plainly bespeak a certain period of time since the *commencement* of what has been, and must continue to be, a *perpetual motion* in the waves, at this spot. The small extent of loss on this very destructible land, plainly denotes but a comparatively short period of time. What the precise date of that period may be, we shall not, in this instance, attempt to prove, as we shall find it elsewhere displayed in a more unquestionable manner, and can from thence revert to it, in connecting and summing up the various parts of our evidence.

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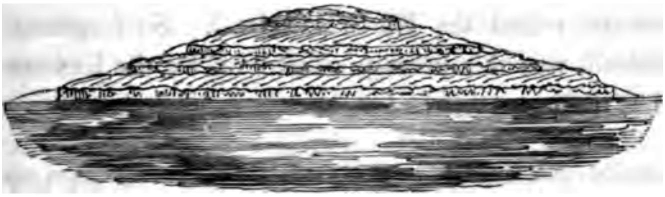
* It is in these clay cliffs, and on the shores below, that such varieties of interesting fossils are found. The crustacea of Sheppey are well known to all collectors of fossils. But it is in *seeds* and *fruits* that these strata are especially rich. On this subject we find the following information, in the Bridgewater Treatise of Dr. Buckland: "Although all these fruits belong to genera whose leaves are pinnated, no fossil pinnated palm leaves have yet been found in Europe. It seems, therefore, most likely, from the mode in which so large a number of miscellaneous fruits are crowded together in the Isle of Sheppey, mixed with marine shells, and fragments of timber almost always perforated by Teredines, that the fruits in question *were drifted, by marine currents, from a warmer climate* than that which Europe presented, after the commencement of the Tertiary epoch; in the same manner as tropical seeds and logs of mahogany are now drifted from the Gulf of Mexico, to the coasts of Norway and Ireland. Besides the fruits of palms, the Isle of Sheppey presents an assemblage of many hundreds of species of other fruits, most of them apparently tropical; these could scarcely have been accumulated as they are, without a single leaf of the tree on which they grew, and have been also associated with drifted timber, bored by Teredines, by any other means than *a sea-current*."—Vol. I., p. 518.

On taking, then, a general view of the form and position of the Isle of Sheppey, we find that it must have been separated from the main land of Kent, and cut off in the form of an island, *at the period when the whole valley of the Thames was hollowed out*, and when the sea and land *became fixed* at their present relative levels: we must conclude that it was thus isolated, by the same *aqueous* agency which scooped out the entire valley; its oblong form, taking the general direction of the current from west to east, corroborates this: and as the valleys of Sheppey, though *short* and *dry*, all terminated, like that of the Thames itself, at the exact level of the sea, when in their complete and perfect forms, we must also attribute them to the same *period* of commencement, and to the same *cause*. *From the day in which they were thus left entire, the action of the waves upon the northern shore of Sheppey has been incessant;* and if we could ascertain clearly, the rate of their destructive power, during the last few hundred years, (knowing, as we do, so nearly, the original form of the land,) we could fix with sufficient precision, upon *the date* of that event, by which the land was here placed at some hundreds of feet above the level of the waters. That this was a *paroxysmal* elevation, and not a *gradual* one, is clear, from the absence of all sea cliffs at higher levels on the sides of this soft island, where the fixed action of the sea, even during a few months or years, must have occasioned marks which could not have been obliterated. Had this elevation been effected by such periodical upheavings, as are supposed, by some able geologists, still to be in action, we must have seen in the soft soils of all such islands as this, a succession of sea-cliffs, at every variety of level, somewhat like the following.



Such, however, are nowhere to be seen in Sheppey, nor in any other place that I have yet met with. We cannot then be justified in reasoning and theorizing on events of which we have no evidence. We must, therefore, conclude that the Isle of Sheppey, and, by analogy, the opposite and *still unbroken* (because *protected*) shores of Kent, towards Milton and Faversham, were elevated above the waters at no very distant period, by a movement approaching to *paroxysmal,* and not by such long-continued and gradual upheaving, as has been supposed in some celebrated geological theories*.

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* It is probable that the curious and very obscure subject of those parallel marks on the sides of some valleys, commonly termed

From the study of the Isle of Sheppey, we may now proceed to a more enlarged model, as seen in the Isle of Thanet. This island, though scarcely now deserving of the name, was formerly separated from the rest of Kent, by an estuary of considerable extent, which, in the time of the Romans, formed a sheltered passage into the mouth of the Thames, and was commonly preferred, even long subsequent to their time, as being more suitable to the imperfect navigation of that early period, than the boisterous course, round the North Foreland. So important indeed, was this passage considered by the Romans, that they established a strong military station at

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parallel roads, may here occur to the minds of some readers, as supposed proofs of former higher levels of water. Since undertaking a careful study of the phenomena of *valleys*, I have examined with much interest and attention, those celebrated marks of this kind, in Glen Roy, and in some of the neighbouring valleys, in Invernesshire. Without having been able to throw the smallest new light on their real origin, I may mention two or three facts which lead me to the fullest conviction, that they never formed, as some have supposed, the margins of *lakes*, which have been lowered by successive convulsions, and their barriers finally swept away so completely, that not a vestige remains to show where they stood.

1*st.*—The marks show no signs of the action of water, except their *parallelism*, which certainly, at first view, forcibly presents to the mind the levels of water. But on a minute examination of the *composition* of those *roads*, by cutting through them in several places, where they were best defined, no *sand* or water-washed *gravel* was to be seen, and the same *soils* prevailed, as on the sides of the hills, above and below them.

each extremity, one being now termed Richborough, (formerly *Ritupium;*) and the other, where the church of Reculvers now stands (formerly called *Regulbium*). This estuary, though probably intersected by channels of sufficient depth for the navigation of that period, even at low tides, never could have been of any great depth, and must always have been either extremely shallow, or altogether dry, during ebb tides, with the exception of these channels. The rivers Stour and Wantsum wind their sluggish course into the sea, through the still growing sandbanks of this estuary. On the deepest of these channels was situated, the thriving sea-port town of Sandwich; and the waves then washed the slightly rising ground, formerly isolated, on which the castle of Richborough still stands; though the sea is now at

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2nd.—It is very certain, that, however formed, they have occurred *subsequent to the grooving out of the valleys*, which are as well defined *diluvial* valleys, as can well be seen; chiming in with each other, so as clearly to show their *simultaneous* origin. The marks are seen to follow the roundings of the smooth hill-sides, even into some of the smallest side valleys, where a lake would have been completely sheltered from every wind, and could have had no ripple to occasion such marks.

3rd.—These marks are quite *local*, and of comparatively trifling extent; nor do they appear in many of the valleys, where water *must have been*, if we entertain the theory of their lacustrine origin.

They certainly form a very curious subject of speculation; but no theory has yet been advanced, by which they are satisfactorily accounted for.

two miles distance, and Sandwich has long since fallen from its high estate, as a commercial port.

There is, perhaps, ample evidence to be found, of the comparatively short duration of the present state of things in England, in the curious history of the rapid change that has taken place, in this now dry and fertile estuary. But, instead of constructing arguments on such sandy and shifting foundations, I shall prefer a structure based on the solid rocks themselves, in which we know that no change by *addition*, or in the way of *growth*, has taken place, such as we find in Romney marsh, in this very bay of Sandwich, and on every other low coast, exposed to the fluctuating influence of the tides. Within one thousand years of our own time, the natural accumulations of gravel, sand, and silt, in all our low coasts, has been sufficient to convert what was once a shallow sea, into the most fertile meadows, and frequently with but little assistance from the helping hand of man. In the case now before us, we find, from the projecting position of the Isle of Thanet, obstructing as it does, the free current of a powerful southerly set of the tides into the Straits, that an *eddy* of great extent occurs, in the sheltered nook of Sandwich (or Pegwell) Bay; so that such sedimentary matter as may be imported by the waters, has sufficient time quietly to subside, and thus gradually to accumulate, in the same manner as we see on a minute scale, behind every large stone, in a brook or river. If such has been the rapid effect of this process, during only a few hundreds of years, how can we hope to be able to extend it to periods of many *thousands?*

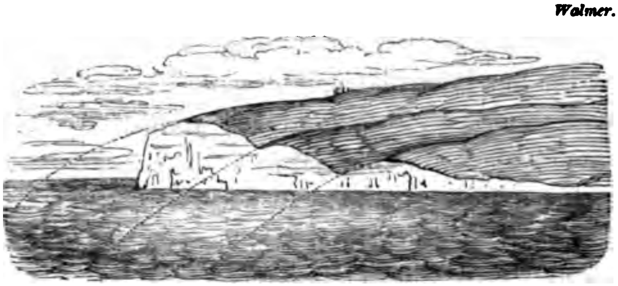
The Isle of Thanet is a table land of most uniform appearance, and of a somewhat oblong square form; being about nine or ten miles in its utmost length, east and west, and about five miles in the widest part, north and south, from Cliff's End, on the Sandwich road, to the point of the North Foreland. It is entirely composed of a continuance of the same chalk, as forms the downs of Kent, from Canterbury, towards Dover and Folkstone, though it nowhere attains so great an elevation, by a hundred and fifty, or two hundred feet. The summit levels of the island are one hundred and fifty feet above the sea, at low tides; and when standing on these heights, and looking around, it would seem as if the whole island was of exactly similar elevation. Such, however, is not the fact; for level as it may appear on a general view, there is scarcely a spot strictly so, of five hundred yards square, in the whole of its extent. A minute examination of its surface, shows the *universal slope* which prevails, either towards one hand, or towards the other. These easy inclinations, when traced out downwards, lead to lower valleys of the smoothest forms; and, at length, from one to another, they end either in an *entire* state, in the sea's level, or in an *abrupt section*, pointing towards the same general termination. It is scarcely necessary to add, that the universal characteristic of this table-land, is *smoothness;* nor is there the slightest exception, unless where the coast is exposed to the sea's action, where the presence of *a perpendicular cliff,* is as much a matter of course, as the absence of such cliff is, on the parts protected from its incessant friction. The whole may be compared to the rounded, but smooth surface of the sea, when agitated, during a calm, by a ground swell.

Of the innumerable valleys, which thus everywhere compose the surface of this island, there is not any one in which there is a running stream, even of the smallest size. The idea of rivers, therefore, having scooped out valleys, is here completely refuted; and yet there are here, as elsewhere, two facts which clearly show that these valleys *were scooped out of continuous and horizontal chalk strata, by a power of waters;* these are, 1*st,* the continuance of the strata, in an undisturbed state, as seen in the cliffs, at the mouths of all the valleys, the lines of flint corresponding, one with the other, on either side of the opening; and, 2*nd,* that universal fact already more than once referred to, of each valley opening into the one below it in the series, *exactly at that level which water would point out,* and never, either too high, or too low. The valleys of Thanet resemble closely, in this respect, those of the continent; they may, therefore, be safely studied as a model; and both cases must be attributed to *a similar cause,* and to *a similar period.* The Isle of Thanet forms, then, a small promontory, which was, at one time, cut off by an arm of the sea, from the main land of Kent; and, we find that that passage has now been converted, partly by nature, but assisted by art, into a rich tract of marsh, or meadow land; that the valleys which opened into this former shallow sea, being protected by their position, from the effects of the winds and waves, *universally remain, to this day, in the same entire forms, which they presented, the very day after they were first scooped out;* while all those of a precisely similar character, and flowing from the same sources, but which chanced to open towards where the sea now beats with force, *have been gradually cut short,* by an action, the progress of which, we daily see advancing before our eyes. We have, therefore, the fullest right to conclude, in this case, as in that of the Isle of Sheppey, that these latter valleys were, likewise, continued in their present slopes, *to the level of the sea;* and that *the day before the waves began their abrading action, the whole island was in a perfect state,* as it came from the hands of that agent, by the power of which it was moulded into its present undulating forms. Knowing then, the original form of the lands which have been destroyed, we can, by careful observation and measurement, ascertain the exact extent of their loss; and thus, arrive at some definite idea of the *time* necessary for the work of degradation.

The general outline of the Isle of Thanet is as follows: and it appears, from hence, that it has lost, on its *exposed* side, but a very small portion; while in

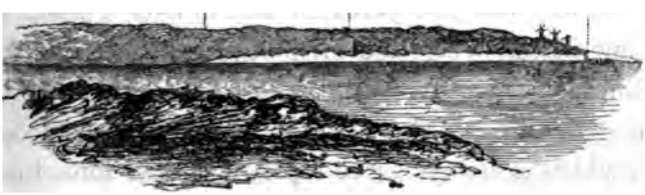
The Isle of Thanet.

the sheltered parts, towards Minster and Saare, where the tide formerly rose and fell, but without any violence, it still continues in its originally perfect form. These facts are in complete accordance with what have been already described as presenting themselves on the coast, from Walmer Castle towards the South Foreland, on the one hand, and towards Deal and Sandwich, on the other; Walmer Castle being situated on the very point where the protected and the exposed slopes are seen to come in contact, as in the following view.



The South Foreland.

Now it is very evident that such *points of contact* are of the highest interest, in the elucidation of the amount of waste in sea cliffs; for it is there that we can best ascertain the former shape and extent of what has now disappeared. A contact precisely similar, is seen at Cliff's End, on the southern face of the Isle of Thanet, in Pegwell Bay, at the spot where the Sandwich road ascends the first slope of the island. On examining this point, from the marshes below, and at a little distance, we see, to the eastward, the slopes cut short by cliffs all the way from Ramsgate and Pegwell, towards Cliff's End. Here, however, the sea begins to lose its force, owing to the sheltered situation of the bay; and as the *cause* thus disappears, we see, in exact proportion, the *effect* gradually diminish, and at length also disappear. But the *same elevations*, and the *same slopes*, are seen to the westward of Cliff's End; they are all there, however, *still in a perfect state*, and thus form a complete index, to point out the extent of the land of which the eastern slopes have now become gradually deprived.



South-east Point of the Isle of Thanet.

Thus, as when we see the site of some deep and ancient inland quarry, in the base of a smooth and regularly rounded hill, we can confidently assert that there must have been a time when the smooth forms which surround it, were prolonged, and *entire,* and consequently, that the interruption to this smoothness, must have been *subsequent* and *artificial;* so, also, in cases like that under our consideration on the sea coasts, we can as little doubt the former prolongation of the surrounding slopes; and as confidently fill up the outlines of what *has been,* merely by attending to the like forms in what *still remains.*

It is, therefore, self-evident, that if we can find two slopes, *of precisely the same degree of inclination,* the one being *perfect* to the level of the sea, while the other *is cut short by a cliff,* near its lower extremity, we have the means of exactly ascertaining the amount of the loss, by carefully levelling up the face of the *former,* until we reach the amount of the elevation of the cliff of the *latter.* This has been done in several instances, on the Isle of Thanet, as well as on other parts of the coasts of Kent and Sussex, and on the French shores. The results of many measurements, have given an average loss of *about nine hundred yards, or nearly half a mile;* in some places, where the inclination is great, and the cliffs consequently high, the loss being only two or three hundred yards; while in lower cliffs, the decay of which is always more rapid, it is seen sometimes to extend to nearly a mile*. By this process, we reduce the question to the simple problem of "*the perpendicular and the hypothenuse being given, with the angle, to find the length of the base.*" For if two lines, not parallel, cannot be extended both ways without intersecting each other; and if, *in every case*, on our coasts, the *horizontal* line of the sea and the *sloping* superficial line of the shore, being prolonged, invariably intersect each other, within a very few hundred yards, it follows that *at this point of contact, the waves of the one must have first broke upon the solids of the other*, and thus must have commenced an action, the effects of which we still see in progress, at a rate which varies according to the powers of the acting and resisting forces. And as *like causes* produce *like effects*, we should discover similar unequivocal marks of the sea's violence, at various elevations, so deeply engraved upon the land as not to be effaced by any natural action, however long continued. Such testimony, however, being entirely wanting in England, we cannot be justified

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* The process of destruction in these cliffs, is the result of a combination of causes, connected chiefly with the break of the waves. In the town of Dover, and also at Ramsgate and elsewhere, such cliffs as have become protected from the breaking

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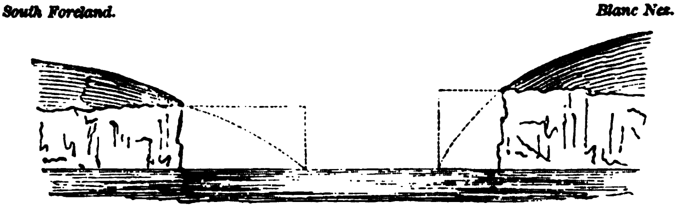
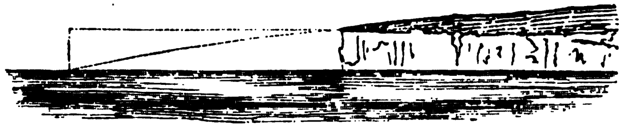
surf, by the buildings and harbours, suffer no perceptible change. In the case of the exposed cliffs, the operation is very similar to that at Niagara, though on a smaller scale, and by a slower process. The foundations are gradually undermined; the salt of the spray decomposes the rock; the alternations from wet to dry, and from frost to thaw, materially assist in splitting the strata into splinters; and after the shock of almost every fall, deep fissures are left, which become enlarged by frost, and finally terminate in the detached masses being precipitated into the sea. Thus, by the sea below, and the atmosphere above, the work is *equally* advanced; for the cliffs themselves are almost always quite perpendicular.

in entertaining, for a moment, this very prevalent idea. We have, in every instance, the perpendicular height of the cliff, and the angle at which the surface points to the level of the sea, with a regularity which never materially varies. We are thus enabled to measure the extent of the loss, with remarkable precision.



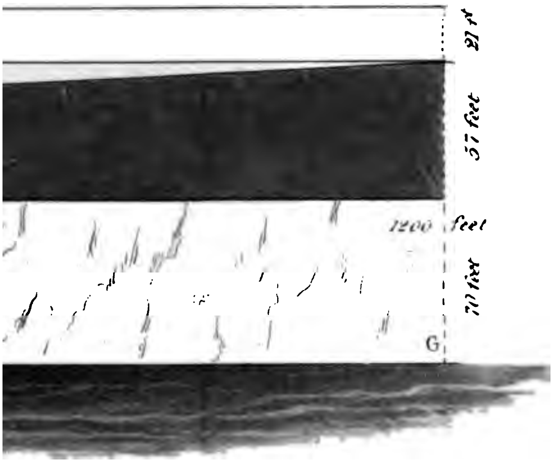


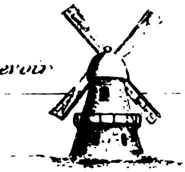
Cliff near Ramsgate.

Among many measurements of this sort, which it is unnecessary for me to detail, I shall describe, by way of example, one which took place on a spot peculiarly suited to the purpose, from the extreme regularity of the forms, and from its immediate neighbourhood to slopes *exactly similar*, but still *unbroken by cliffs.* The place, thus selected, is immediately to the westward of the Royal Crescent at Ramsgate, and extends towards Pegwell and Cliff's End, where *the same slopes* terminate *unbroken* in the marshes. In the annexed plate, the upper

No. 20
to face page 2

it level of the Isle of Thanet & of Ramsgate new water reservoir

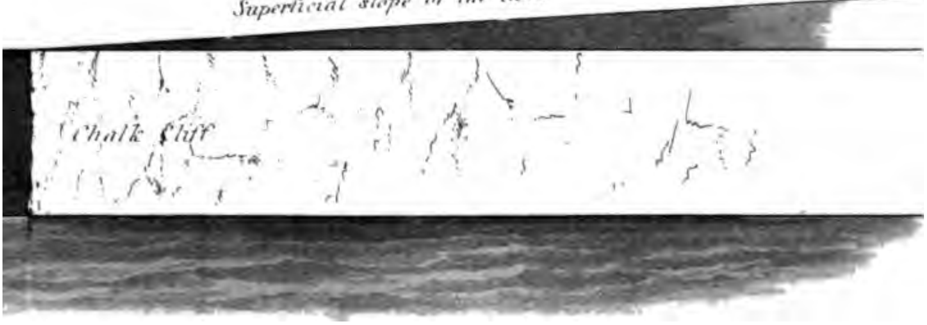




Ramsgate Mill.

Cliff — — 70 feet
rise in 1200 feet from the Cliffs margin } —57
To the summit level of the Island 21
148 feet above the level of the sea

Superficial slope of the land



figure, No. 1, shows the actual inclination of the ground, for a distance of twelve hundred feet, measured from the cliff, nearly up to Ramsgate windmills, the elevation of the base of which, is within twenty-one feet of the summit levels of the island. In the whole of this distance, the surface of the slope is as straight, as if drawn with a ruler. There is a rise of *fifty-seven feet* in these four hundred yards; and the cliff, at the lower extremity of the inclined plane, is suffering visibly, year by year, from decay. The lower figure, No. 2, is a continuation of the same line of slope, until it touches the level of the sea, which it does in the course of one thousand, one hundred and thirty feet, the cliff being seventy feet in height. Now, although, as at Niagara, we do not know with that certainty, which we should have done, had fixed marks been established fifty or a hundred years ago, that the exact rate can be depended upon, at which the cliff is now retrograding; yet we do see, on all hands, that the progress of decay is visible, even in the course of five or six years; and all old persons attest, that, within their memory, the loss of land has been very remarkable. In computing the action of the sea, in all such instances, it is necessary to attend to the well known and obvious fact, that *the lower the cliff is, the more rapidly does it fall, and vice versâ.* It is on this principle, that we can account for the present form of most *bays,* and of their projecting head-lands. In the former, the lands of the interior circular space, are always found lowest, and are generally occasioned by the opening of a valley, which, in its original state, was, of course, low; while, in proceeding from this low centre, towards the extending promontories, we find the ground gradually rising into the form of ridges, or sides of the valley, the points of which, having also suffered from the waves, (though at a much slower rate, on account of their greater elevation,) stand out as head-lands, with lofty cliffs, protecting the bay from all side winds. With this principle, then, constantly in view, when we come to consider the degree of rapidity with which such a solid wedge-shaped mass, as is shown in No. 2 of the plate, has been destroyed, rising from nothing, up to seventy feet, and with the future certainty of retrograding, in a progressively slow ratio, for about one thousand five hundred feet more, before it can attain the summit level of the Isle of Thanet; we perceive how rapidly the first part of the operation must have been executed, and how gradually this rapidity must have abated, up to the present day. We are, in such instances as this, confined within very narrow limits, both as to *time* and *space;* for in the short period to which history extends, we know with certainty, that no change of level has taken place on these shores. If, then, at the end of these four thousand historic years, we find the average loss, at this spot, to be but about *one inch per annum,* we obtain an average loss of between three and four inches, during that time, throughout the whole eleven hundred and thirty feet; in other words, the first loss might be at the rate of several *feet* a year, and has been gradually dwindling down to its present small amount of only about *one inch**. Let us now, on the other hand, divide the total loss, of eleven hundred and thirty feet, by a longer period, such, for instance, as *ten thousand years;* we find, in this case, that the eleven hundred and thirty feet (or thirteen thousand, five hundred and sixty inches,) would not admit of much more than an average loss, *over the whole,* of one inch per annum, which we now know to be about its present rate; and we should be thus forcibly closing our eyes upon the sloping forms of the land, and also upon the well known fact of *the increasing ratio of loss*, in exact proportion to the *lowness* of the cliffs. As this higher period, then, would lead us to a conclusion which is evidently erroneous, it is vain to look deeper into the boundless periods so frequently alluded to in geology. We may now look back with something more than *suspicion*, as to the accuracy of that popular theory, which the following passage is intended to support and elucidate. " The time required for upraising a mass of land to the height of several hundred yards," (in the case of the Isle of Thanet, it is but one hundred and fifty-six feet, though in the Kentish and Sussex downs, and also on the French coasts, which must of course be viewed with reference to similar facts and measurements, the height is much greater,) " must usually be so *enormous*, (assuming, *as we do*, that the operation is effected *by ordinary volcanic forces*,) that the aqueous and *igneous* agents will have time, *before the elevation is completed*, to modify the surface, and imprint thereon the ordinary forms of hill and valley, by which our continents are diversified. *But after the cessation of earthquakes*, these causes of change will remain dormant, or nearly so*." We here find it admitted that, as earthquakes and their dire effects are now entirely unknown in Kent, and must probably have been so during the whole of its existence, the elevation of the island, as far as its one hundred and fifty feet of height go, must have been paroxysmal, or, at once; and we must extend, therefore, a similar conclusion, by the laws of just analogy, to all the surrounding lands, though of much greater height, which bear the impress of precisely similar forms. It is in vain that we attempt to discover in these coasts the smallest marks of the *igneous* agencies here spoken of. Of *aqueous* agencies we have, every where, the plainest proofs; but of the long-protracted or intermittant upheavings, supposed, by the same author, to have attended the gradual and laborious birth of all dry lands, we can discover not the smallest marks throughout the whole of this district*. Every thing in the strata *underneath* the surface, bespeaks the absence of such violent effects as generally accompany volcanic convulsions; while all the phenomena *on* the surface, proclaim aloud an *aqueous* agency, at one particular period, which period we are enabled to approximate, by an attentive study of such original forms, and of such continued friction as have just been described. We have, in such instances, only to reason with regard to what *has been*, by a study of what *is*, and what we see *will be*, in order to discover the real path of truth. We plainly see, in examining all these coasts, that in a thousand, or in ten thousand years, the edge of the cliffs on which we now walk will not exist, and that instead of being elevated, as we are, far above the waves, the geologists of that day, must walk upon what is now the *foundation* of the rock on which we stand, left dry by the ebbing tide, and covered, like those below us, with a protecting coat of sea-weed. What must thus happen to future philosophers, now happens to ourselves with reference to by-gone times, and to masses of solid rock already washed away. Unless we forcibly reject all analogy, our forefathers might have foretold what we now see has taken place; and in the same manner, we can now with certainty foretell what our descendants must witness in succeeding ages; for as an action which is *ceaseless*, is now slowly destroying the lands at D. in the plate, so has it progressively advanced from A. to B. and C. (fig. 2.); and so must it continue to advance from its present place, D., to E., F., and G. (fig.

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* It may appear to some, who have witnessed the masses of chalk which, from time to time, fall from the cliffs in Thanet, that a rate of *one* inch per annum must be greatly too low an average for the present times; and they may urge as a reason, that they have frequently known the paths along the cliffs to be interrupted, or endangered, by the fall of masses measuring from ten to twenty feet in length, and from one to five or six feet in thickness. This is, no doubt, true; but it must not be forgotten, that for every one of such masses, we have, in common seasons, many hundred yards in which no change has been perceptible for years past; and it is thus only on an average of a long period, that we can fairly judge of the general loss, along a whole line of coast. During six years, that I have studied the cliffs of Thanet, so *slow*, though *ceaseless*, has been the loss, that I could not, for some time, bring myself to think it was even so much as *one inch* over the whole face of a cliff. But in the winter of 1835–6, during which there chanced to be a combination of severe gales, and of high spring tides, so great was the loss, and so numerous the falls, that I was taught to calculate, on the longer periods, as the only just method of striking a true average.

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* *Principles of Geology*, Vol. III., page 114, &c.

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* We find, in like manner, the author of the *Bridgewater Treatise on Geology*, speaking of "the point of time, when *we know* that England was in the state of *a new-born land, emerging from the sea* of a tepid climate†." The reader may, perhaps, suppose that the author was here alluding to the *birth* of England in its entire state, above shown to have taken place within a few thousands of years. This is, however, far from being the case: he is speaking of *coral reefs gradually reaching the surface of the sea*, and thus, by means of floating seeds, becoming in time covered with vegetation. He supposes England to have *begun to arise*, in the same manner; and this hypothesis is built upon one unique specimen of a fossil fruit, found in the oolite, near Charmouth, in Dorsetshire, and of a kind often found on the low coral islands of the tropics: subsequent subterraneous *upheavings, during millions of years*, have, by little and little, reared to its present respectable elevation, this noble structure, which has for *some few centuries* held the ascendant in the world!

† *Bridgewater Treatise on Geology*, Vol. I., page 506.

1); but beyond the point at A. we can by no means advance, under the guidance of the existing laws of nature. We there reach the *commencement* of a new state of things; and it is as clear as any mathematical demonstration, that as, *on a certain day*, this action, which is now *ceaseless*, must have begun, by the breaking of the first powerful surf on a fixed shore, so, *before* that day, there was *there* no such action, simply because there was no fixed land for such surf to beat upon.

Beyond this point, and beyond the date (whatever it may be, of five, ten, or a hundred thousand years), to which it points, we cannot advance; we must there embark on the obscure sea of *theory*, without chart or compass; and those, alone, who have witnessed from the more safe and solid rocks, the devious course of such adventurers as have braved the dangers of its shoals and quicksands, can form a true idea of the hazards to which such adventurers become exposed.

Before concluding this part of our argument, as connected with the Isle of Thanet, I must request the attention of the reader to a few sketches from nature, from various parts of its exposed shores, all of which, without exception, exhibit *effects* in exact proportion to their *cause*. Where the full force of the waves is felt, there the loss appears proportionally great; between this *maximum* loss, and the parts of the island altogether sheltered from the breaking surf, we see the cliffs gradually becoming lower, while the elevation of the land continues the same. They, at length, entirely die away, as is seen at Cliff's End; and are no more seen, until, after making the circuit of the inland marshes, by Minster and Saare, we again open upon the exposed shore, to the eastward of Reculvers. Thus we find, as might be expected, that about the North Foreland and King's Gate, the loss has been greatest, from the greater exposure to the prevailing easterly and northerly winds.

The North Foreland light-house is a handsome tower, situated near the summit level of the island, at the head of a regularly inclined plane, at about three hundred yards from the edge of the cliff.

North Foreland Light House.

It is here, as elsewhere, obvious, that while slopes and valleys, falling to the *eastward*, from a certain general elevation, have been thus cut short, slopes and valleys *precisely similar*, and falling from the same elevation, are seen tending to the *westward*, at Saare, in their unbroken state, each originally ending at the same level of the sea. In like manner, at

King's Gate, a small bay has been formed in the *embouchure* of a deep valley, (the lower grounds having, as usual, wasted quickest;) the loss is there accordingly great, and threatens certain destruction to the neighbouring buildings, at no very distant period. The following view represents the picturesque house of Mr. Holford, on the southern promontory of the bay, built upon a smooth sloping ground, which is falling rapidly away into the sea.

King's Gate.

The well-known watering place and port of Ramsgate, (or *Roman's Gate*, as it probably was anciently called), has evidently owed its origin, as a fishing village, to the sloping and sheltered *embouchure* of a combination of deep and well defined valleys, which meet there from various quarters, and which beautifully proclaim their aqueous origin. To any one who casts a glance from a little distance, at the inclined slopes between East Cliff House and the harbour, it must be very evident, that here, also, as on the west of the town, (of which a section has already been given), the slopes, in their yet unbroken state, must have reached the surface of the sea, at but a few hundred yards from the present cliffs. The superficial line, when thus prolonged, touches the level of the water, rather *within* the extent of the present harbour, and the land certainly never extended beyond that point, being a distance of only about five hundred yards. At Broadstairs is also seen a beautiful example of the manner in which a bay gradually becomes more deeply indented into the land, while the projecting promontories remain extended on either hand*.

We hear much, in the present theories of geology, of the *slow* but *constant* change, *by gradual elevation*, that is supposed to be going on between the levels of sea and land, in all countries. In districts violently affected by volcanic convulsions, such changes may occasionally occur, though, even in these, the evidences hitherto adduced, have proved extremely vague and contradictory. But we can discover no such proofs on any part of our own coasts; and, therefore, the theory can never be generally applied. Indeed we have the most conclusive testimony in opposition to this idea, in the phenomena of all our shores. At low water, we can almost every where walk on rocks covered with sea-weed, and that to a considerable distance. Every foot of these rocks must, in its turn, have formed *the base of a cliff;* and, in like manner, the base of the present cliffs will, a thousand years hence, be similarly situated, and overflowed by the tides.

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* The numerous *stairs*, as they are there called, will serve to show the original form of the unbroken shores. They consist of deep cuts through the chalk cliffs, so sloped down to the shore, as to enable carts to pass, with sea-weed, by which, as a manure, the lands are so highly benefited. These inclined planes were probably in the form of *stairs*, in ancient times, before carts came into use. They require to be frequently re-cut, as the sea encroaches upon their lower parts.

These tides must evidently rise and fall to the same depth *now*, that they did on the very first day on which they broke upon the *smooth and sloping shore.* But instead of this rise (which, in the Isle of Thanet, is about eighteen feet, in spring tides,) being confined to a small space, as formerly, it has now gradually worked out for itself a much more considerable breadth : we feel convinced, on examining the gently sloping form of this space, that there has been no change in the relative levels of sea and land ; and that we may now walk upon the very same rocks on which the Roman soldiers may have gathered shell fish, fifteen hundred years ago, when stationed on the hill above, where the remains of their entrenchments have been lately found. It becomes a question for future inquiry, whether the above sloping form in the lower rocks, is not one which may, *in time,* place the cliffs beyond the reach of the breaking waves. At the present time, we very rarely find a cliff so placed; but it does appear, that a continuance of such slope, must ultimately have this effect, unless the daily action of the advancing tide, over the weed-covered rocks, reduces them also in a like proportion. If this latter action be in force, it is so extremely slow that even its very existence becomes questionable: and in this we clearly perceive that rocks are not materially affected by the mere flow of waters *over* them: there must be an actual *break* of the wave, *against* a resisting solid, in order to produce that degradation which is so obvious in the case of sea cliffs.

Here, then, we have, in the Isle of Thanet, a perfect model of a larger island, or continent, and on a scale well suited for easy comprehension and examination. We find it composed of a rock which is admitted to be *marine and sedimentary.* It was, therefore, at some former period, *under the waters of the ocean.* It is now, however, a dry land, raised one hundred and fifty feet *above* the level of its native deep; there was, therefore, *a certain day* when it first became dry land. In our endeavours to ascertain that day, we discover that the surface of the whole island bears conclusive marks of having been moulded into its present regular forms, by a power *of waters,* draining off the surface of this sedimentary formation, like the tide ebbing from some rounded mud bank; leaving channels in the form of valleys, all ending precisely at the level of the sea, in which, though there may be, and are, heights and hollows, there can be no *valleys,* in the true sense of the word, simply because there is no action below the surface of the waters, by which a complicated system of inclined planes, agreeing in all its parts, can possibly be produced*. This aqueous agency, when it ceased to be in force, left this new dry land in a perfectly smooth and rounded form, with its surface every where more or less covered with beds of sand and gravel, which may be seen in all the sections of the cliffs, (especially at Dumpton stairs and Pegwell,) slightly intermingling with the surface of the chalk, in waving forms, like marbled paper. In these superficial beds of sand, &c. termed *diluvium,* fossil bones of elephants and of other animals are sometimes found†. We then find conclusive evidence of these rounded slopes having been broken in upon, by the force of the waves; and that this new force must have had its *commencement,* as the previous aqueous agency had its

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* Mr. De la Bèche, in his *Researches in Theoretical Geology,* lately published, argues against the common theory of the *bursting of lakes,* as the origin of valleys, and gives a map of the area round the British islands, within soundings of one hundred fathoms, to show that no valleys are produced by tides or currents.

† I have in my possession, a grinder and other bones of an Asiatic elephant, or *mammoth,* which were found in this diluvium, in digging the cellar of a house in King-street, Ramsgate. The cliffs to the eastward of Brighton, on which Kemp-town is built, have been called "*the elephant cliffs,*" from the number of such fossil bones, which they contain, *in the diluvium.* We thus connect these fossils, in the most consistent manner, with the period *immediately subsequent to the excavation of the valleys, and with that of the deposition of the gravel beds.* This, we have just seen, cannot be more remote than *four or five thousand years ago.*

termination, on a certain day. This day cannot have been more remote than about four or five thousand years, for the reasons which have already been explained. We know from history, that it was not within two or three thousand years; therefore, between these two dates, the *termination* of one force, and the *commencement* of the other, must be found; and *both must necessarily have been simultaneous,* as the nature of the last (*viz.* of the waves) admits of no pause or cessation. Here, then, is an instance, on which we can lay our hand: and, as Paley has said, in a similar argument, while proving the fact of Creative *Design,* "one single fact, weighed by a mind in earnest, leaves oftentimes the deepest impression. For the purpose of addressing different understandings and different apprehensions, for the purpose of exciting admiration of the Creator's works, we diversify our views, we multiply examples; but for the purpose of strict argument, *one clear instance* is sufficient; and not only sufficient, but capable perhaps of generating a firmer assurance than what can arise from a divided attention*."

In this instance, we ground our argument on what Newton has termed "*veræ causæ,*" or, as Bacon expresses it, "*glaring instances,* which stand naked and alone, and this in an eminent degree, or in the highest degree of power." We have here one of those "*glaring instances*" of a recent commencement X to which most geologists stand opposed. I shall reserve, however, the general inferences, which naturally flow from the subject, until we have examined the remaining model which was proposed, in the yet more varied forms of the Isle of Wight, presenting, as they do, precisely similar phenomena, though all under circumstances suitable to the difference of its position on the coast of England.

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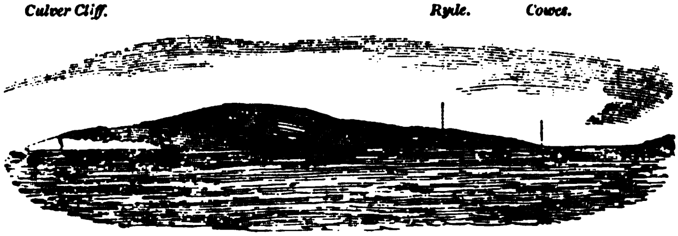
* *Natural Theology,* p. 121.

X as he creates & assumes
to meet his delusions

CHAPTER VII.

DESCRIPTION OF THE ISLE OF WIGHT AND ITS COASTS; TOGETHER WITH THE EVIDENCES WHICH THEY PRESENT, OF THE RECENT ORIGIN OF THE ISLAND, AS A DRY LAND.

AFTER the examination of the two preceding models, as examples of a *principle* which may be applied to similar phenomena, on lands of a much wider scale, it may appear almost unnecessary to extend the inquiry further, in search of examples; as a mere glance at the Isle of Wight is sufficient to show that it exhibits a form and outline extremely similar to those of Sheppey and of Thanet. But this beautiful island, is probably not so well known to some of my readers as to others; and as it presents a model of larger size than the preceding, so its geological formations are also more complex and interesting; and it thus becomes well suited to advance our views, and to prepare us for an examination of the whole British coast, on our way to those of a still more enlarged and continental scale. That part of Hampshire, termed the Isle of Wight, is divided from the main land, by a channel of some miles in breadth, and of sufficient depth and importance to be navigable by large ships, in all states of the tide. It therefore still retains the character of a distinct island; and it is probable, that this passage will long continue free from all such accumulations of sand and silt, as have changed the character of the Isle of Thanet, because the set of the currents through this channel, is still extremely powerful. The island is of an irregular square form, about seventy miles in circuit, with one of its corners projecting towards the west, at the sharp point of which, are the well-known rocks called the Needles. It is so placed, as to present two of its sides towards the sea, and the other two, towards the Southampton river, and the shore of Lymington and Gosport. The general profile of the island, as seen from Portsmouth, on the north-east, is as follows :—



Isle of Wight.

It presents a surface of universal *smooothness;* its summit levels, consisting of rounded chalk downs, situated to the south of the centre, from whence the numerous valleys flow towards the north and south, and terminate, as usual, at the exact level of the sea, wherever they have not been cut short by sea cliffs. There are but few of these occupied by running streams, which, in so small an island, are, of course, of but trifling importance. These rise towards the south, and are drained off towards Cowes, and the northern sides of the island. The other innumerable valleys, from which the Isle of Wight derives much of its beauty, are all *quite dry*, though they have the same forms and the same exact terminations in the level of the sea, which have been already described as characterizing all the dry valleys of the earth.

The geological phenomena of this island, have been the subject of much study, and of not less speculation, among scientific men. The formations have all an evident relation to those of the neighbouring coasts of Dorset, Hampshire, and Sussex; so that we are left in no doubt, that the division now existing, has been cut out of *continuous* and *solid* strata, *at the same period*, and *by the same agent*, to which we attribute the formation of the smaller valleys. The passage between the island and the shore, may indeed be regarded merely as a wide valley, into which, the smaller side valleys on both sides fall, as in every other similar case; as, for instance, in the neighbouring beautiful estuary of the Southampton river, and in the estuary of the Thames, already described in the case of Sheppey. As has been said, the central ridge of the Isle of Wight, consists of chalk downs. To the north of these, the formations are all what are termed tertiary, or superincumbent on the chalk, in the series of rocks; while to the south, some of the secondary formations, or those below the chalk, compose that part of the island which extends from Culver Cliff, round to Compton Downs, in Freshwater Bay, both of which, are themselves on the chalk. The deep and short channels which form the southern valleys, and which are cut through these softer sands, and argillaceous strata, are termed *chines*, where the retrogression of sea-cliffs has given them a precipitous and picturesque character. The chalk formation, and the strata immediately above and beneath it, are, in most countries, seen either horizontal or nearly so, in the position of their strata; but what gives peculiar interest to the Isle of Wight, in a geological point of view, is, that there, we find a remarkable exception to this usual arrangement. The chalk, instead of being horizontal, or only slightly inclined, there stands, in some places, completely *vertical;* and its strata, thus set on edge, afford us the opportunity of examining the deposits both above and below it, in point of age and position, together with, in some cases, *the point of contact*, which, of all geological facts, is amongst the most interesting and instructive*.

It is not my intention to enter upon the debatable ground which regards the *cause* of this singular and interesting arrangement of the strata in this island. My object is rather to study the age of the Isle of

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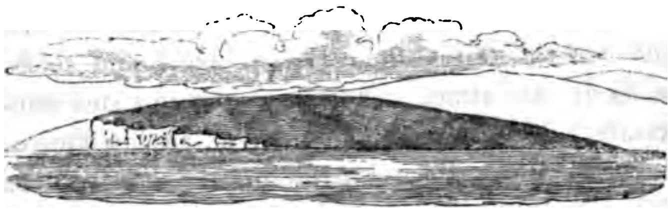
* "The chalk at Goslar, and the green sand near Blankenberg, in the Hartz mountains, are highly inclined, or nearly vertical."—*Principles of Geology*, Vol. I., p. 66.

Wight, *as it now stands;* and if we find, during our research, that any gleam of light is thrown upon the other, and more common subject of inquiry, the result of our examination will only prove the more satisfactory and conclusive.

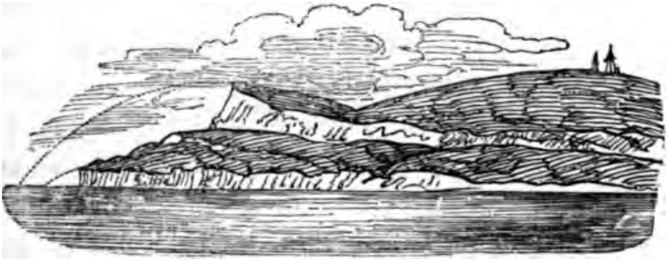
The first and most instructive fact, then, which presents itself to the mind, on taking a general survey of the whole island, is, that all the valleys *towards the south,* are *cut short* by sea cliffs, while no instance of such cliffs, is any where to be found *on the northern sides* of this island. As the smooth and rounded forms, however, of the higher parts of the whole island, on both sides of the central ridge, *are the same,* we are led to the conclusion, as in the similar cases of Sheppey and of Thanet, that they equally ended, when in their original and perfect forms, at the same level of the surrounding sea. The cause of this difference, is also here found to be precisely the same. There is a powerful surf constantly breaking on the southern shores; while towards the north, the tides rise and fall, without any violence, and consequently without injury to the gently sloping shores. Here, then, we find, as in both the former models, *cause and effect,* in the most perfect accordance; while, at the points of contact, at Culver Cliff, on the east, and in Alum Bay on the west, *we see both gradually and harmoniously subsiding; and finally, they entirely disappear.*

I have not had an opportunity of making many actual measurements of the slopes of the land, and the heights of the cliffs, in the Isle of Wight, such as have been more fully described in treating of the Isle of Thanet; but the same results must be obvious to every observer, the general outline of the sloping and rounded hills, leading the eye irresistibly and *within a very few hundred yards*, down to the exact level of the sea. We cannot, therefore, hesitate in coming to the same conclusion, as to the comparatively *recent* elevation of this island into a dry land, as that to which we are led by the more minute consideration of the slopes of Thanet. In Freshwater Bay, and at Culver Cliff, the evidences are so simple, that when once pointed out, they cannot be mistaken even by the most superficial observer. The following is a view of Culver Cliff, as seen from St. Helen's roads.



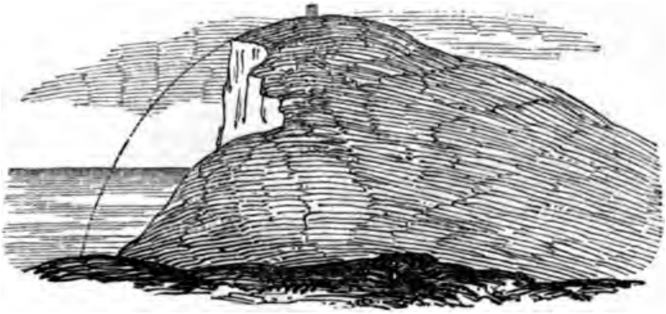
Culver Cliff.

St. Katherine's Point consists of a different formation, being a strong clay, termed *gualt*, inferior in position to the chalk; and as the latter is seen on the upper downs, in a position approaching to vertical, the gualt, having had but little support below, has evidently *slipped downwards*, at an early period in the history of the island, and the appearance of *an upper cliff* is thus seen, along the side of the denuded chalk rock, while the subsequent action of the sea has produced, lower down, its usual effects, and an appearance like *a double cliff*, is thus occasionally to be seen, as represented below.



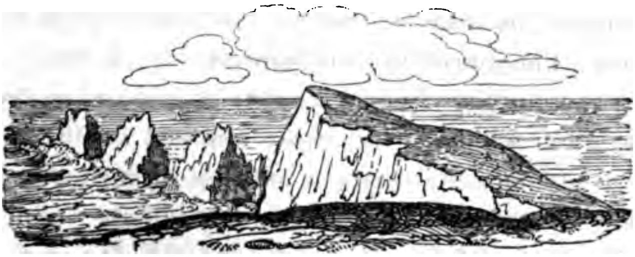
St. Katherine's Point.

But of all the points on this most interesting shore, that of the Needles is certainly the most instructive, for the elucidation of our present argument. At this Point, the highest part of which is *six hundred and seventy feet* above the sea's level, the chalk, in its upright strata, stands alone, and in a smoothly rounded ridge of most regular form, having little or no soil on its surface, but sinking, like the hollows of an unbroken wave, into deep and well-defined slopes, which, on the north side, are less broken than on the south, merely because they have been there less exposed to the violence of the waves. On walking along the summit of this lofty ridge, called High Down, towards the light-house, the following view of an elevated point presents itself; and, as in proceeding westward, we see, on the right-hand, the forms of the more perfect parts of the hill, we cannot, for a moment, hesitate in filling up the gap which has been made on the south-side, by such an outline as is given below, and which leads the eye to the level of the sea, at but a very short distance from the base of the cliffs below.



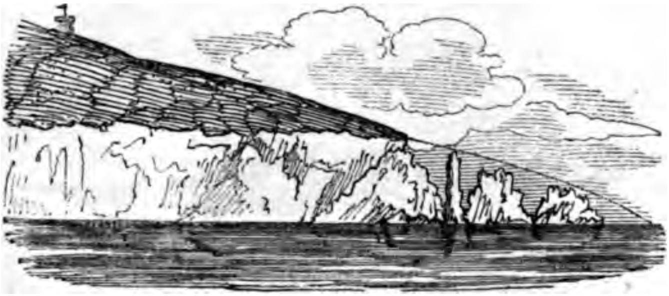
High Down.

Advancing still further along the same summit, we, at length, gain the following bird's-eye view of the detached rocks called the Needles, from their sharp and pointed forms, when seen endways. There we still observe a continuance of the same fact, of a greater waste having taken place on the south, than on the north side of the promontory, the *cause* of which is not less obvious.



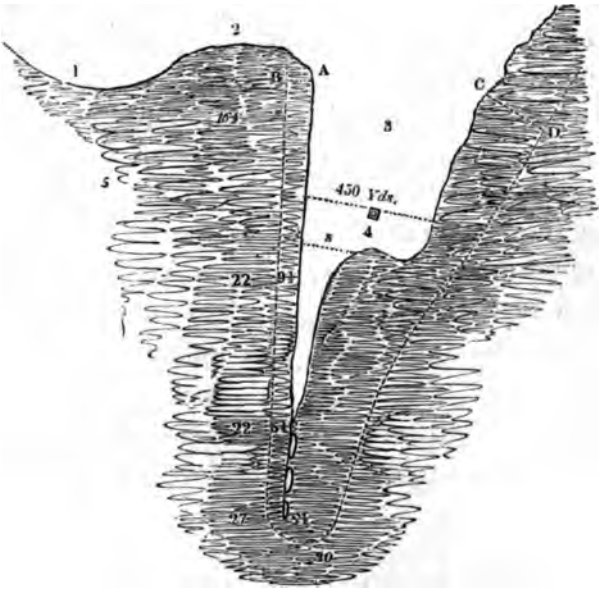
Bird's Eye View of the Needles.

When seen in profile, from Alum Bay, on the north, this remarkable promontory presents the following appearance; and, as in every other case of sea-cliffs, we can, at a glance, and with the most perfect conviction of its having been the true primitive form, fill up the deficiency, as seen in the dotted line below.



The Needles.

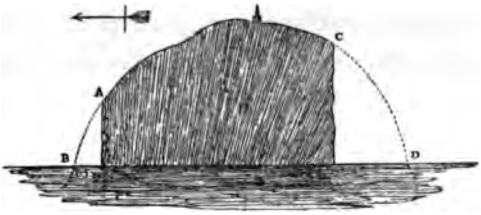
The total breadth of this rounded promontory, at the light-house, is now only about four hundred and fifty yards; while, further on, towards the Needles, it becomes a long and narrow *spit*, of only about a hundred yards at the root, and gradually diminishing to the very point, from which the highest Needle is separated, as may be seen in the following ground plan. The line of chalk is continued quite straight; and the furthest Needle consists of a sharp wedge-like rock, which, being most exposed to the full swell of the western sea, is also most wasted, and will, consequently, be the first gradually to disappear. The following is the ground plan of this remarkable Point, in which the soundings are also marked in feet, on the north side.



1. *Headon Hill.*
2. *The Sand Cliffs.*
3. *High Down.*
4. *The Lighthouse.*
5. *Alum Bay.*
S. *Width*, 100 *yards.*

And here we cannot fail to remark, in this wedge-shaped promontory or *spit*, that as the north-side forms a perfectly straight line, while the southern outline is at an acute angle with it, we cannot prolong both these lines without their intersecting each other within a very short space, and thus indicating, by yet another proof, the very recent origin of the action, by means of which this angle, once so acute, is, year by year, becoming more obtuse, and with a complete certainty of the whole point being, in time, worn away. Thus, whether we view it horizontally, or vertically, we are led, in both cases, to the original form of this point of land, which has, as yet, been but little encroached upon by the action of the sea.

The cross section of this narrow promontory at the light-house, presents the strata of the chalk in the northern cliff, in a position absolutely *vertical;* while they gradually incline to the south, towards the opposite side, as may be seen in the splendid section in Scratchet's Bay. The total section of the chalk strata, therefore, is as follows.

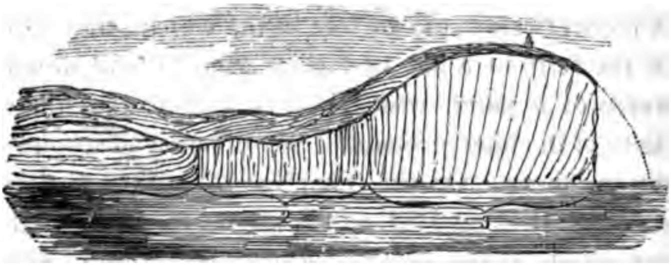


Section of the Chalk, at High Down.

But if any doubt were entertained as to the primitive superficial forms of this singular promontory, *before* the waves commenced that ceaseless friction which we now see in progress, we find, in Alum Bay, the most conclusive proof of all those forms which I have ventured to fill up by dotted lines, having been the true original profiles of the Isle of Wight. For on looking down from the summit of the cliff at A. (see the above section,) into the clear water below, in a calm day, we see a ledge of rock, covered with sea-weed, and about three or four feet under water, *which exactly corresponds, throughout the whole length of the spit, with the superficial outline of the sloping turf above ;* and by following with the eye, the continuation of that line, from the upper turf, by the dotted line, to B., we have the fullest ocular demonstration that this chalk ridge was originally left in a round and smooth form; and that the loss in Alum Bay, by the sea's action in its more diminished power, amounts already to not more than a width of *sixty-five yards*, which width is regular, *from one end to the other*, of the long, and straight line of the vertical chalk cliff, in that Bay, as pointed out in the ground plan. Nothing, therefore, but the more impure, and disturbed state of the sea, at the southern face, prevents us from having a like ocular demonstration of the same fact, on that more exposed side of the promontory; and we may, therefore, confidently, draw the line from C. to D., which thus completes the originally rounded form of the whole, when yet unbroken by the ceaseless action of the waves.

It will now be seen that this wedge-shaped promontory of the Isle of Wight was originally of the form indicated by the dotted outward line, in the ground plan; and that its great exposure to the south-west gales, must have occasioned, the moment it became a dry land, an immediate commencement of a cliff. This cliff began, then, like all other sea-cliffs, *on a certain fixed day.* The *cause* and *effect* have been, and now are, in exact accordance. On the west and south, the loss has been *greatest*, and the cliffs are, consequently, *highest*. On the north, the rock was exposed only to *a reflected action*, in the sheltered retirement of Alum Bay. There, accordingly, the cliffs have been *less extensively* wasted, and are, consequently, *less high;* and we have there also the advantage, which I have not enjoyed on any other spot, of having *ocular* testimony to the line of submarine rocks, which originally bounded the island in its entire state; thus demonstrating the correctness of the theory, by which I had filled up the blanks on other shores. We now, also, plainly perceive a most obvious *cause* for the existence of the Needles. The chalk being there *vertical*, of course wastes away by splitting *from the sides*. Had it been otherwise, had the beds been in their more usually *horizontal* positions, these rocks, now so sharp, would either never have been separated into detached pillars, or would have been of an obtuse and *rounded* form. These Needles are, of course, gradually wasting away, and are now only three in number. A fourth fell in 1772. But as the outer and lowest Needle is worn away, another is in constant preparation, by the degradation of the long and pointed *spit*, of which they have all once obviously formed a part. This succession of *Needles* must continue, until the whole of this long and narrow point disappears, under the violent friction of the restless waves.

Having thus brought the question of the original forms of the lands broken by sea cliffs, to a point of complete ocular demonstration, in this remarkable promontory, it is not my intention to do more than glance at the neighbouring celebrated section of the tertiary strata, as seen in the vertical beds of clay and sand in Alum Bay, which present phenomena, perhaps unique in their kind, at least among such as are *exposed to view*, upon the earth. The following section may assist the reader in forming some idea of the arrangement of the strata, from Headon hill, on the north of the Bay, to Scratchet's Bay, on the south of the Light House:—



Section in the cliffs of Alum Bay.

The vertical beds in the centre (No. 2), are those tertiary strata of sand, which exhibit that endless variety and brilliancy of colours, which some of the neighbouring peasants have so ingeniously arranged in bottles, representing every variety of design and tint. On the right (No. 3), are the chalk strata, in contact with the former, being, at that point, quite vertical; while, in the short space of only four or five hundred yards, we find them gradually declining from this upright position, and at length, inclining towards the south, at an angle of only about 45°, where they touch the water in Scratchet's Bay. This is a very remarkable fact, and especially since the gradual changes in the slopes of the chalk strata, occur within so small a space as only a few hundred yards; for it is evident, that had the land, on the south side, extended a few miles farther than it does, we should have seen this gradual subsidence of the disturbed strata, terminating in the more usually *horizontal* positions, in which they are actually seen further to the eastward, on the English shores. If we prolong the lines of the strata of High Down, and extend them, in theory, below the surface of the waters, they lead to the form of a fan, and thus seem to tend downwards to *a point,* which greatly adds to the singularity of the phenomena, and the difficulty of accounting for them. On the left (No. 1), are the tertiary strata of Headon Hill, which are nearly horizontal; but which, at the point of contact with the vertical beds, are suddenly bent upwards, at their extremities.

In the account of the Isle of Wight, by Mr. Webster, in Vol. II. of the *Geological Transactions,* he computes the whole thickness of the beds, of which the island consists, at not less than three thousand feet, of which, one thousand four hundred and eighty one, are above the chalk; nine hundred and eighty-seven in the chalk itself; and five or six hundred feet, in the lower strata. In one of the vertical beds of loose sand, we find several layers *of flints*, extending from the bottom to the top of the cliff. As these rounded pebbles of the chalk could not possibly have been deposited as we now see them, they must have been raised from a horizontal position, at the same period, and by the same movement as that which placed the chalk on the edges of its strata. The whole of this movement must have been *at one time*, and *extremely partial;* for the horizontal beds of Headon Hill, all turn up, *but only at their extremities, where they join with those that are on edge.* They are thus distinctly shown to have been already deposited, *before* that movement took place; and as we now have demonstrative testimony of a great change of level having occurred, at the period when this island became a dry land, (that is, about four or five thousand years ago,) we have a right to assume that the derangement of the strata also occurred during that movement.

It is scarcely necessary to point out the necessity we are under, in the case of the Isle of Wight, of regarding its elevation into a dry land, as strictly *paroxysmal*, and not by those intermittent upheavings, in long periods of time, which some geologists advocate, as the real and only origin to which a dry land can be attributed. The height of the chalk ridge at High Down, is upwards of *six hundred feet;* its perfect smoothness and rotundity clearly show, that the sea has never beaten upon it, at any higher fixed level than that at which it is now working; and we are imperatively called upon to draw a similar conclusion, over the whole island, where similar smoothness so universally prevails. Even the wildest theorists have not supposed that common earthquakes, (to a long-continued repetition of the shocks of which, with the usual intervals, they attribute the elevation of all lands,) have ever raised such masses as the Isle of Wight, at one throe, and especially in the absence of all semblance of volcanic phenomena, which are nowhere to be seen within some hundreds of miles. It is for them to show by what *other* power, *in existing nature,* such an island as this, could have been *at once* elevated above its native deep.

The singular varieties in the nature and position of the numerous strata, here displayed in so narrow a compass, form a rich subject for discussion, in a geological point of view; and when to these are added, the older and deeper-seated strata, which are exposed in the southern and central cliffs of the island, we at once perceive that the Isle of Wight, as a whole, is deservedly regarded as a most interesting source of scientific speculation, as well as highly admirable, from its extreme superficial richness and beauty.

We may now, as in the former instances, shortly recapitulate the leading features which this island presents. In the first place, then, it is of sufficient size and elevation, (as well as being possessed of great varieties in its interior formation,) to justify *similar conclusions, from similar facts,* if found in the neighbouring shores, and in the valleys of the English coast. In the next place, we have here as clear evidence as in the two former examples, of the *original similarity* of the forms and slopes, on *both* sides of the central ridge. We find, as before, this original perfection *broken in upon on one side, and still entire on the other,* the *cause,* in both instances, being perfectly obvious; for while at Culver Cliff, in Freshwater Bay, or at Shanklin Chine, we find romantic and precipitous cliffs, still wasting before our eyes, by the fretting action of the waves, we see, in such sheltered spots as Fishbourne Creek, and the neighbourhood of Ryde, of Cowes, and of Newtown, wooded and unbroken slopes, gently inclining to the very edge of the waters.

On proceeding to the high promontory of the Needles, we find the forms of the land still more distinctly marked; and we have there, complete demonstration of the fact formerly described from other more general evidence, of the higher lands wasting less rapidly than the lower. In Alum Bay, we find the loss on the chalk rock, to be only about *sixty-five yards* in breadth; while, on the opposite and more exposed shore, it may amount to three or four times as much. These are both but trifling losses, when viewed on the great scale; and they must appear still more so, with reference to those prodigious periods, so constantly dwelt upon in geology. I have not had the means, it is true, of connecting this trifling loss, with any fixed and definite period, as has been done in the Isle of Thanet; but, it only requires a degree of leisure greater than I have yet been able to bestow upon it, to attain that desired end, on many parts of this well-marked coast. Of this, however, we must be fully persuaded, that *exactly the same time* must have been occupied in the formation of *the whole* of the cliffs of this island, as in those of Alum Bay, which exhibit a loss of only about sixty-five yards; and that this trifling loss cannot consistently be spread over a period so long as even eight or ten thousand years. We are led, on the contrary, with an infinitely greater degree of consistency, to such a period as the actual measurements near Ramsgate have pointed out, and which cannot, by any means, be extended *beyond four or five thousand years.*

CHAPTER VIII.

APPLICATION, TO THE MAIN-LANDS OF ENGLAND AND THE CONTINENT, OF THE PRINCIPLE WHICH HAS BEEN ESTABLISHED, IN THE FOREGOING CHAPTERS.

HAVING thus completed the examination of the three islands, which were at first proposed by way of *models*, or examples, on which to fix our principles of reasoning, and to lead us, step by step, to similar conclusions, on a wider scale; and having found, in all the three, the most conclusive evidences of *a simultaneous origin, at a very recent period;* it becomes necessary that we should now extend our views to the nearest main-lands, in search of a similar accordance between *cause* and *effect*, by which we may also be led to similar distinct conclusions.

From the Isle of Wight, then, we may proceed to examine the coasts of Dorsetshire, Hampshire, and Sussex, where, however, we shall find no one instance of facts, in the smallest degree at variance with what has just been proved at the Needles. We universally find a range of inland elevations, of the smoothest and most rounded forms; consisting of a variety of strata, both above and below the chalk, which latter constitutes the principal rock in the higher ridges, or *downs*. We find this smooth country every where intersected by innumerable valleys, of which by far the greater number are quite *dry;* but which all chime in with the general system, in that harmonious manner already described, while treating of valleys. On the coasts of Dorset and Devon, we have the finest examples of valleys of denudation, cut through chalk, green-sand, oolite, lias, and red marls, in grooves nearly at right angles with the coast, while the strata are *undisturbed*, and correspond on both sides. We find various rivers, terminating, as usual, in the sea, but flowing in winding valleys, cut through strata that have every mark of complete accordance on the sides, and which, therefore, bespeak *no volcanic violence from below*, nor any local subterraneous upheavings, to occasion fissures. In the estuary of the Southampton river, and along the whole coast which is protected by the Isle of Wight, we find the same smooth slopes and *unbroken* shores, for which we see so consistent a cause, in the northern slopes of that island, from Alum Bay, by Cowes, to Culver Cliff. But no sooner do we quit those parts of the coast which are thus protected by the Isle of Wight, than we find the rounded slopes invaded near their base, by the abrading action of the waves; while the universal inclinations of the superficial outline towards the surface of the sea, as plainly announce a former *entire state,* at no very remote period of time. Those who are acquainted with the coast scenery, from Selsea Bill, eastward by Brighton, to Beachy Head and Dover, will, at once, recognise such forms as have already been so fully described, as existing in the Isle of Wight. At Brighton, such slopes, and especially such *coombs,* or dry valleys, are every where to be seen; and wherever they are exposed to the action of the waves, they universally terminate in *cliffs,* which are daily becoming higher, but which, in the retrospect, have as evidently been *lower,* until, *within a few hundred yards,* the eye is led to a point, on the surface of the sea, *beyond which, there could be no cliffs,* and where these lands must, consequently, have once been seen in a perfectly smooth and unbroken state.

It is sometimes urged, in opposition to this fact of an unvarying slope of the shores towards the sea, that there may have been a much greater extent of land destroyed, than such slopes would indicate. It has been asked, 'why should not *other hills and vales* have formerly belonged to the present shores, and been worn away during those long periods of which geology treats?' The reply to this objection is extremely simple: in judging of the original extent of the land, we are strictly confined within the narrowest bounds, by the forms, and the terminations of the valleys, which form the drainage of a country; for had other hills and vales, of indefinite extent, ever existed beyond their present *embouchures,* there could have been no outlet for the flow of rivers. Besides, if such hills once existed, why should we *never* see them now in existence? Cliffs are now almost invariably growing *higher*, as a natural consequence of their retrogression. Had other hills ever existed beyond them, we must have, *occasionally*, seen examples of them, where the destructive process would have been attacking their landward sides, and where the cliffs would yearly be getting *lower*, instead of higher. In the whole course of my examination of the British coasts, I have seen but one instance of this effect, and it arises from a very obvious *local* cause. That instance is found, in the celebrated Shakspeare's Cliff, to the west of Dover. It happens that this hill forms the side of a valley, which runs in a slight degree *parallel with the coast*, for a very short distance near its termination, after which, it makes a bend, and opens, like all other valleys, into the sea, between the cliff and the town. The sea has thus originally attacked a part of the hill, *on the side*, instead of on the extremity, as is more usual; and so soft is the chalk in this place, that the destructive process has been extremely rapid, large masses falling away every year. This cliff must, like others, have begun by *increasing* in height. It has now, however, passed the summit of the hill, and must, consequently, become *lower*, until the whole is worn away. A glance at this singular exception, when viewed from the summit, instantly suggests the real cause of this *descending* process;

and a little farther to the westward, the hill presents the same appearances as all the other chalk downs around.

In Newhaven Bay, to the westward of Beachey Head, we find a beautiful example of what has already been described, with regard to the more rapid decay of the less elevated rocks; and of the projection of promontories, where the height of the land has occasioned a slower retrogressive action. The valley of the river Ouse, here, also, presents a point of the highest interest, with reference to our present subject; having been grooved out from a variety of most interesting strata, in the Wealden rocks, and terminating in the sea, through a transverse section of the chalk downs, presenting, every where, the most rounded forms, and being joined, on both sides, by tributary valleys, *mostly dry*, and each at its own proper level in the system. We thus perceive that a *simultaneous* action, scooped out the whole; while the *recent period* of that action, is distinctly proved, by the trifling loss already sustained by the chalk hills, on the neighbouring shore, which all indicate *a perfect form*, at but a short distance from the base of the present cliffs. On proceeding eastward, by Hastings and Folkestone, to the Forelands of Kent, east of Dover, we find numerous instances of low grounds, where the more solid rocky formations have been protected from the action of the waves, by vast accumulations of sand and silt. *There*, accordingly, *we find no cliffs;* and at the point of contact, (as for instance, between Beachey Head and Hailsham Marshes,) we see the cliffs terminate, in the most gradual manner; and the unbroken slopes, which incline towards the marshes, serve plainly to point out what were the original forms of those lands which have subsequently been invaded by the sea's action.

There is no part of this southern coast of England, where a greater number of well-defined and conclusive instances of *diluvial valleys*, of smooth slopes, all pointing to the level of the sea, and of sea-cliffs invading such slopes, are displayed, than within a mile or two, around the port of Dover. The principal valley, occupied by a small stream, is joined, in the immediate vicinity of the town, by numerous dry valleys on both sides, the whole presenting the most beautifully smooth and winding forms; and, as in all other cases, each side valley terminating in the main drain, at a higher or lower level than its neighbour, according to its situation in the group. The Castle of Dover stands upon the eastern boundary of the great valley; while the more modern fortifications of The Heights, occupy the opposite escarpment. A little to the eastward of the Castle, and within two miles of the town, may be seen the most conclusive examples of short and deeply marked *dry* diluvial valleys, the forms of which plainly bespeak their former terminations, *in an entire state*, at the level of the sea, though they are all now cut short by slowly retrograding cliffs.

The loss from this coast is there clearly calculable, and does not amount to more than *four or five hundred yards*. If I were called upon, indeed, to name a district where all the evidences of this interesting question might be studied, within the smallest compass, it would be difficult to point out a more compact example than that which the valley of Dover, with its numerous tributaries, presents.

In studying these phenomena, from the chalk heights, near Dover, we are naturally reminded of the very common opinion which has long been entertained, even by scientific men, *of the former junction of the French and English shores*. We can scarcely feel surprised, that this idea should be so prevalent, when we consider the very striking similarity, to the eye, of the cliffs on the two sides of the British Channel. Those who have not attentively studied the subject of our present consideration, may imagine that a sea-cliff is a *natural* object, instead of being, as I have now shown, a merely *mechanical* result. We hear persons passing between Dover and Calais, expressing a conviction, that if the two shores could be *again* placed in conjunction, the projecting and retiring cliffs would be found *almost to fit each other;* and, like the parts of a dissected map, would thus show that they had formerly been *torn asunder*, and placed at their present distance, by some awful convulsion of nature. Others, who are better acquainted with the progressive action of the waves, conceive, that, at some very remote period, (perhaps a million of years ago, when England was inhabited by elephants and other tropical animals, and clothed with a tropical vegetation,) the two countries formed one connected land; and that the present Channel has *gradually* been formed, by the long-continued action of the sea*. In the year 1753, this subject came under the consideration of a French scientific body, who offered a premium for the best essay that should be written, in proof of the fact. This was awarded to the celebrated Demarest, then a young man, who was supposed, completely, and for ever, to have established the point *in the affirmative;* and thus to have brought forward, at least one conclusive proof, of the vast age of the existing continents. This opinion is still held to be correct, by some of our ablest geologists†. But the slightest glance at the forms of the land on both sides, will now be sufficient to show how completely erroneous was this conclusion. We now find proof to demonstration, that the respective shores have never extended, *as sea shores,* more than a few hundred yards beyond the present cliffs; and that, as all the valleys and inclined planes of both countries, (of whatever length, whether of the Ouse at Newhaven, or of the Somme and Seine at Abbeville and Havre,) have their slopes *exactly suited to their present terminations in the sea,* we must conclude that the two countries have always been as distinct as they now are, and that they have not been exposed to the abrading action of the waves, more than for a period of a very few thousands of years*.

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* "The first land that rose in the south-eastern extremity of England, may have been placed, where we now find the central elevation in the Weald. Perhaps the *chalk islands* there formed, may have supported that tropical vegetation whereof we find memorials, in the fossil plants of Sheppey; and the shores of those islands may have been frequented, during the ovipositing season, by the turtles and crocodiles, of which the teeth and skeletons are imbedded in the London clay."—*Principles of Geology*, Vol. III., p. 316, first edition.

† "It will hardly be disputed that the ocean might have effected a breach through the land, *which, in all probability, once united our country to the continent*."—*Principles of Geology*, Vol. III., p. 317.

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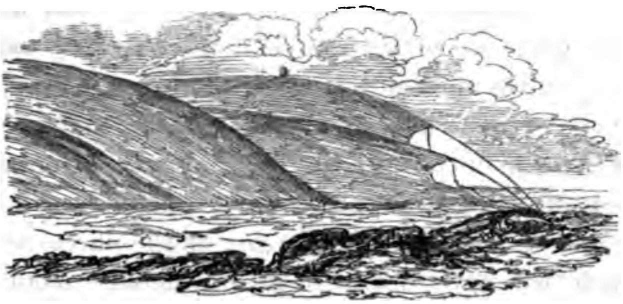
* While employed in the study of this subject, it is interesting to find how near some former inquirers have been, to arriving at the very same conclusions. Thus, in a most interesting paper by Mr. Stevenson, in the fifth number of the Edinburgh Philosophical Journal, (1820,) "*on the form of the bed of the German ocean,*" he says, "One of the most striking and general examples of this kind, may be found in the abrupt and precipitous head-lands, and shores, which we, every where, observe along the coasts, *and which we suppose to have once been of the same sloping and declining aspect with the contiguous lands.* In the production of these effects alone, an immense quantity of *débris* must have been thrown into the bed of the ocean."—p. 50. As the views of this acute engineer were attentively fixed on the hidden forms of the bed of the sea, he thus, as it were by chance, touched upon a subject, which, if followed up, would have at once led him to the very recent *commencement* of that action, and would have proved of the highest interest, in the elucidation of the subject of which he was then treating. In the thirteenth number of the same periodical, we

I have already given a view of the form and inclination of the South Foreland cliffs; we may now, therefore, take the opportunity of being at Dover, to cross the Channel, in order to take a similar view of those of the *Blanc Nez,* to the west of Calais, where the immense range of the chalk formation terminates in a bluff point, on the shore. We there find a great extent of marshy ground around Calais, bounded by the chalk downs which commence the table-land of France, over which, valleys of great extent exhibit their winding courses down to the very level of the sea. From this extensive range of elevated land, numbers of *dry valleys* terminate *in an unbroken state,* at the level of the sea, in the marshes, (like those formerly described at page 209). But the instant one of those rounded points, which form their terminations, comes in contact with the waves, we perceive the usual effects, in the form of a sea-cliff; and although the chalk of Cape *Blanc Nez* falls away with considerable rapidity, the height of the chalk downs makes the loss appear, on the whole, but small, as may be seen in the following view from nature, taken from the marshes, a few miles to the westward of Calais.

find a notice of a work by the Rev. G. Young, of Whitby, entitled "*A Geological Survey of the coast of Yorkshire,*" in which his views of the origin of valleys, bays, and creeks, materially corroborate our present subject, though he attributes them to a much more obscure and complicated cause.



View of Cape Blanc Nez.

When we combine, therefore, the forms of the two sides of the Channel, at this its narrowest point, they present a section somewhat like the following, the soundings in the channel singularly corroborating the view now taken of the subject; being deepest in the centre, and gradually sloping upwards, so as to meet, as it were, the superficial outlines of the land on both sides*.

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* We can now more readily comprehend the entire disappearance of an island of which tradition speaks, as formerly existing where the fatal Goodwin Sands now are, and which was the property of the Earls of Godwin. If such island really existed, it was probably formed of the softer formations; and being beaten upon, on all sides, by the waves, it must have gradually disappeared, by the retrogression of its cliffs. We have an instance perfectly similar, still in existence, and with a certainty of being, in a few centuries more, a like subject of tradition. The island of Heligoland, was once of very considerable extent, and contained numerous parishes and churches. It is of a soft earthy formation, and is wasting rapidly away, by the violence of the surf, which

Without proceeding further, at the present moment, with the consideration of the French coasts, to which we must subsequently return, as the key to the age of the whole continent of Europe *as a dry land,* we may proceed in a rapid survey of the forms of the eastern coasts of England and Scotland, in order to show the *universality* of the phenomena which we have observed in our smaller models. Without dwelling on the fact, which must be obvious to all who pass down the Thames to the sea, that its shores *invariably slope to the very surface of its waters, unbroken by cliffs,* until they become exposed to the waves, in its estuary, we shall pass on to the coasts of Essex, Suffolk, and Norfolk, along the whole of which, the tertiary formations, with their immense and interesting load of superficial diluvium, present the same phenomena, though in less decided forms, from the low nature of the country of which they form the margin. But towards the northern parts of Norfolk, we again find a more marked outline, in the chalk downs which there terminate, as usual, in dry valleys, and in smooth slopes, *except near the sea,* where we again meet with well-defined cliffs. Following the outline of these downs, where they face the marsh lands and fens of Cambridgeshire, around the Wash, we soon quit the sphere of

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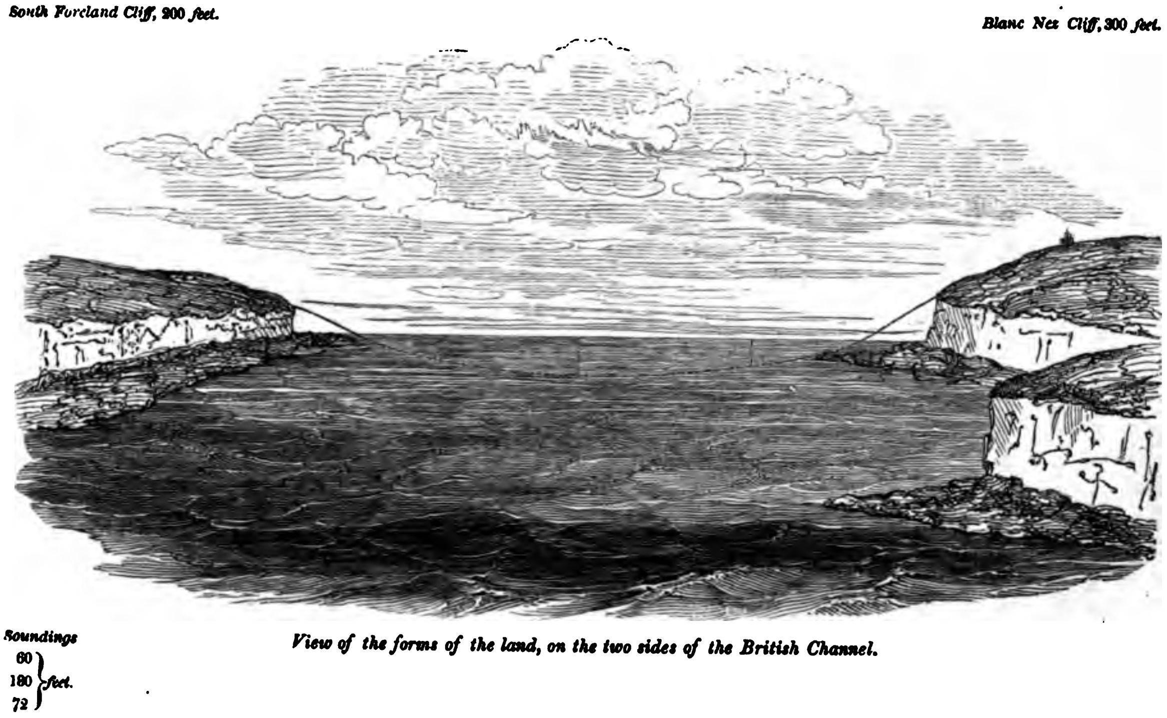
constantly beats upon it, on all sides. It is now twenty years since I saw it; but it was then evident that it could not probably last for any long period.


South Foreland Cliff, 200 feet.
Blanc Nez Cliff, 300 feet.
Soundings
60
180 feet.
72

View of the forms of the land, on the two sides of the British Channel.

action of this indefatigable agent, and, in like manner, we, as usual, lose the *effect* with the *cause*. No cliffs are to be seen on the inland shores, nor on the inland hills, until we reach Flamborough Head, from whence, northward, we find a continued cliff at the base of all the rounded slopes, and extending, with little variety, until we reach the Scottish shores.

There are numerous points on this eastern coast of England, where the decay of the softer formations, and the consequent loss of land, are very remarkable. In Vol. I. of the *Principles of Geology*, its able author has given a very full account of the encroachments of the sea, upon the British coasts; and amongst other facts, he mentions, that "at Owthorne, in Yorkshire, the present rate of encroachment is about four yards a-year*." Without questioning the reality of this great annual amount of loss, which, however, might require farther scrutiny, I shall only remark, that such rapid mechanical action, is but ill-suited to those "enormous periods," on which this author usually calculates, "for the elevation of a country to the height of several hundred yards, assuming," as he does, "that that elevation has always been effected *by ordinary volcanic forces*." It is indeed difficult to define, what period is worthy of the term "*enormous*," in geology; for we find another able Professor of this science, stating that "the geologist counts his time, not by celestial cycles, but by an index which is found in the solid frame-work of the globe itself. He sees *a long succession of monuments*, EACH *of which may have required* A THOUSAND AGES *for its elaboration**." If we apply, then, the ceaseless mechanical action of the waves, to this part of the coast of Yorkshire, for but *one* of these "*thousand ages*," (or for one hundred thousand years,) at the present rate of loss of "*four yards a-year*," we are led to the extraordinary conclusion, that the coasts of Yorkshire must have lost nearly *two hundred and thirty miles*, from their original extent! This result but ill-accords with the testimony borne to much shorter periods, by the superficial forms of the chalk downs at Flamborough Head, and by all the other slopes of the eastern coast of England. It is in fact evident, that the operations of decay, so well described in the above quoted work, are infinitely too rapid to suit the lengthened *periods* which its author has throughout assumed. The time so assumed is purely *theoretical;* we have no distinct idea of such enormous periods. The *fact* of decay, however, and also that of *the originally universal slope of the land to the very brink of the sea, previous to the existence of any cliffs*, is one from which we cannot now by any means escape, without forcibly departing from all those common rules of argument, by which we are guided in our study of nature. The one is a simple *fact*, open to the scrutiny of the most unscientific observer; the other is an inference, also founded, it is true, on *facts;* but they differ most materially in this, that while subsequent discoveries may influence, or altogether do away the *latter*, the *former* must ever remain, as we now see it, as simple and intelligible a fact, as can be found in nature. Now, if the application of this new fact, when applied to vast periods of time, lead to a refutation, *ad absurdum*, of such periods, in such cases as that to which we have just applied it, this refutation is much more apparent, when we take the case of narrow channels, on *both sides* of which, a yearly decay is going on. From Calais to Dover is but twenty-four miles: on both sides of this channel, we find valleys terminating at the sea's level, and cliffs retrograding, by slow, but certain degrees. A long period may be applied to this action; but by such only as theorize on the subject, without having attentively observed the forms of the land. A single glance at these forms, is sufficient entirely to overturn the theory of vast periods of time.

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* *Principles of Geology*, Vol. I., p. 305.

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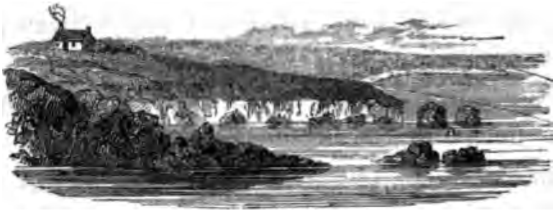
* *Discourse on the Studies of the University of Cambridge* (1833). By Professor Sedgwick.

In proceeding in our scrutiny to the northward, it is highly interesting to observe the same forms, and the same degree of steady, though very limited loss, on the older, and more deep-seated formations, which we had before studied on the chalk, and on the soft strata superincumbent upon it. We pass the mouths of those beautiful valleys occupied by the Trent, the

Tees, the Wear, and the Tyne, which flow over inclined planes of considerable length, from the rounded and smooth summits of the hills of Yorkshire, Durham, and Northumberland. The winding courses of these rivers, are scooped out of the *solid mass*, whether on the harder or on the softer rocks, as in the cases already described, of the rivers of France, descending from the primitive ridges of the Vosges. "It is a fact, deserving of particular notice," says an experienced and practical observer of the coal formations, "that, when the deranged state of the coal strata is considered, throughout even a moderate extent of the Coal Field, *the surface should not partake of the same derangement.* A comparison of the present state of the surface, with that of the interior, affords a complete proof *of the denudation* which must have taken place, *after* the strata were consolidated, and subsequently disrupted. The scooping out of many valleys in the coal districts, could have been effected, *neither by the streams now passing through them*, nor *by casual storms* occasioning local inundations." "The supposition of a small power, acting for an indefinite period, is favoured by the circuitous and uniform flow of the waters in the valleys of the coal districts; but such a power *is totally inadequate* to smooth down the asperities caused by the dislocations of the strata; these asperities, therefore, must have been removed by *a tidal current, deep, and long-continued.*" "The sloping seams, traced to one thousand feet deep, are defined on the surface, whether in the bottom of the valleys, or on the summits of the hills ; consequently, *the power of denudation must have been immense, and its pressure uniformly exerted**."

No geologist, however, residing on the banks of the above rivers, could ascertain their actual *age*, without descending to their *embouchures*, where, alone, we can apply actual measurement to the *time* which has elapsed, and the *space* which has disappeared, since England *was entire*, and since its valleys and shores were fresh from that vast mechanism, which impressed upon them their present forms. The following sketch, on the coast of Durham, may serve as an example of the prevailing forms of the cliffs, and of the hills, on the bases of which, they are cut.



Cliffs on the coast of Durham, north of Seaham.

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* See a beautifully executed quarto volume of plates and sections, relating to the coal measures around Ashby-de-la-Zouch, in Leicestershire, with many able and judicious geological remarks, by Mr. Edward Mammatt, published at Ashby, in 1834. The author of this splendid volume, (which contains nearly a hundred coloured plates, of coal fossils, &c.,) has been many years superintendent of the coal mines, belonging to the Marquis of Hastings, in that district.

A thick bed of diluvium is usually seen reposing upon the solid rock. This wastes away into a sloping form, (as has been described at Niagara,) chiefly by the atmospheric action; while the solid rock below, is worn *perpendicularly*, into fissures and caverns, at its weakest points; and, thus undermined, the superior masses fall away, from time to time, into the sea. On this coast, we find the Magnesian limestone frequently worked into isolated and columnar masses, as at A., in the above sketch. These are invariably *lower* than the solid mass from which they have been detached, by the washing away of the surrounding rock; and they thus serve, (like the pillars left by workmen, in cutting solid piece-work,) to indicate the true forms, before the work was begun; and thus aid us in the computation of the cubic amount of loss, which any well-defined point has sustained.

I cannot expect the reader to follow me through all the details of the Scottish coasts, which I have, myself, studied; but as it forms an object of great geological interest, to find, that the *granitic* shores present the same degree of loss, and sometimes even greater, than the softer chalk and tertiary beds, together with rounded forms, almost equally smooth and well defined, I must request a few moments of his attention, while we examine that part of the coast, from Stonehaven, northward, towards Peterhead, to which allusion has been made in a former chapter[*].

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[*] See page 90.

The rocky formations of a part of this coast are calculated, from their extreme interest, amply to repay the danger and toil which accompany their close inspection. I allude more especially to the space between Stonehaven and Aberdeen; for in these eighteen or twenty miles of coast, we find, exposed to view in the cliffs, *a gradual and almost imperceptible transition*, from the *stratified* conglomerate, or pudding-stone, on which Dunotter Castle stands, to the pure *unstratified* granite, of which the country around Aberdeen consists. On the north side of the bay of Stonehaven, of a part of which the following is an outline, (and where we see a fine instance of the cessation of *effect*, in the absence of a *cause*, in the termination of the cliff at A.,) we find sandstone strata, of a variety of tints, changing, in about a mile, *insensibly*, into micaceous schist, in strata highly inclined. About Portleathon and Finnan, this schist mixes *gradually*, with more and more of quartz and felspar grains; while veins of red granite intersect the schist, and may be studied to advantage on the bare moors, to the north of Portleathon. About Finnan, and Cove, the rock has *gradually* changed into a

Coast to the northward of Stonehaven Bay.

small grained granite, which, towards Aberdeen, exhibits larger crystals of felspar and talc; and, at length, becomes that fine grained granite, which is so extensively worked for exportation, around that city. There are, perhaps, few situations where the geologist has a better opportunity, within a day's walk, of having ocular proof of the *insensibility* of these transitions, from the lower secondary strata, to the most perfectly defined granite: and a close examination of this district, together with abundant corresponding transitions, as seen in the vale of Alford, to the west of Aberdeen, has brought to my own mind a still stronger conviction of the former *aqueous* fluidity of the primary rocks, than the study even of Glen Tilt itself. Since my visit to this interesting district, I have been greatly delighted with the perusal of a work by Dr. Boase, entitled "*A Treatise on Primary Geology*," in which, certain anomalies are exposed, which have greatly obscured the science, and the removal of which, seems to open a new and more correct view, of the early formations of our planet. The result of his acute observations during a long study in Cornwall, where he resides, has led Dr. Boase to the conclusion, that the primary rocks, both granitic and schistoze, *are of contemporaneous origin*, only differing from each other, in their component parts being so aggregated, as to produce different kinds of structure. The following passage will illustrate this view :—"In considering the composition of the granitic and schistoze rocks, we find that they show all their members, however dissimilar in their appearance, *repeatedly passing into each other*, by the most *insensible* gradations; and not only so, but these groups have the same relations, wherever they meet together. This character is so strongly marked, that even *stratified* limestone, when it joins granite, as in Glen Tilt, partially loses its fissile structure, and becomes siliceous; the granite, at the same time, becoming very quartzose; and when a crystalline schist has a granular structure, and meets with a fine-grained porphyritic granite, so as to render the junction apparently *abrupt*, then large crystals of felspar, *traversing both rocks, remove all doubt of their identity*."

From this short digression, we may now return to the consideration of the waste in the granitic and schistoze cliffs, which bound the coast of Aberdeenshire. As is seen in the sketch just given, the whole of that county presents *a smooth and rounded form*, in the hills; while the valleys of the Don and the Dee, with their numerous tributaries, offer as fine instances of the *diluvial system*, already explained, as are to be found in the softest, and most ductile of the secondary rocks. The whole of the low lands towards the east of Aberdeenshire, are covered with *diluvium*, which, to the north of the city of Aberdeen, is heaped into smooth and rounded hillocks, forming an undulating low country, for many miles. The Bullers (or Boilers) of Buchan, near Slaines Castle, are deep and narrow hollows, worked out by the sea, in the red granite; and into which, a tremendous swell frequently breaks, which occasions, as may easily be supposed, a frightful commotion: and when we see the facility with which that rock, in its weaker parts, often gives way, before the force of this action, and even by the atmospheric changes of temperature from frost to thaw, we cannot connect long periods of *time*, with the very limited degree of *space*, which has, as yet, been worn from the smooth slopes of that coast, the general forms of which may be conceived, from the following sketch of the point to the south of Slaines Castle, as seen from that place.

Granite cliffs near Slaines Castle.

A little farther to the northward, we find a highly striking and obvious instance of *cause* and *effect*, in the sea-cliffs, at the opening of the inland Firth of Cromarty, into the Murray Firth. This basin, together with the low grounds on its shores, form a circular space of considerable extent; and it is divided from the more open and exposed estuary, called the Murray Firth, by a lengthened ridge of smooth and rounded hills of moderate elevation, which ridge appears to have been cut through, in its centre, and a narrow opening to have thus been formed, through which the tide ebbs and flows, in the inland basin. The rounded sides of this narrow channel, are so similar, the one to the other, (each having a cliff, where the waves break upon it,) that they have acquired the name of "*The Sutors of Cromarty**." The cliffs of this narrow and rounded ridge, are, of course, highest on the side which faces the open sea of the Murray Firth; and as the swell of the waves, during north easterly gales, is here very powerful, the cliffs, on both sides of the narrow channel, are likewise high and well defined. But no sooner do we enter within the more sheltered Bay of Cromarty, than the cliffs are seen gradually to become less high, and, at length, *they altogether cease*, in accordance with their *cause*; and, in their place, we find the smooth and sloping hills extending, *unbroken*, down to the very margin of the water, in the same manner as has been already described, in Alum Bay in the Isle of Wight, and elsewhere on the sheltered parts of coasts of England. No where, then, can the proofs of a *definite period of commencement*, be stronger and more obvious; and, it becomes clear to every understanding, that before this *commencement* of the ceaseless action of the waves, the coasts of Scotland were, here, in a smooth and unbroken condition, and quite fresh from the agency of that power, whatever it was, which has moulded that country into its present sloping superficial forms.

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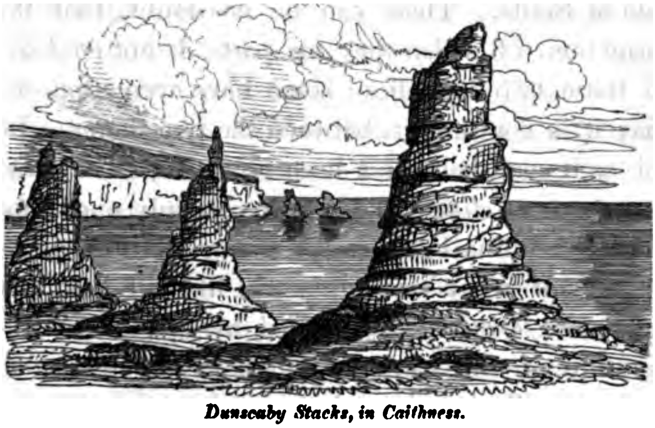
* From the Latin, *Sutor*, a cobbler, which is used, in the same sense, as a Scotch word.

Without proceeding round the whole coast, it will be sufficient for our present purpose, to take two more examples, still farther to the north, in the island of Orkney, and on the Caithness shore. The forms of the main land of Orkney very strongly resemble the treeless parts of the south of England, and consist of a continued succession of *gentle slopes*, which even remind us of the Isle of Thanet. The coasts of the Island of Hoy are remarkable for their bold and lofty cliffs, in the excavation of which, by the violence of the waves, isolated pillars, of the most picturesque forms, are sometimes left standing. That called " the Old Man of Hoy," is thus described by a recent writer: " The sea, which rushes upon this side of the island, with a fury not to be surpassed in any part of the world, has wrought tremendous fissures in the coast, which presents a long and broken line of stupendous precipices and awful chasms, exhibiting, in conjunction with " the Old Man," a scene of uncommon grandeur and sublimity. The gradual encroachments of the sea, might almost induce an expectation of the final overthrow of this island; and if the duration of the world were sufficient for the completion of the work of devastation, the soft materials of which the island is composed," (red sandstone) " would, probably, yield to its violence.

No part of the coast of Great Britain, is, perhaps, grander than that of Hoy, though, from its uniformity, it is little picturesque. We pursued our route to the foot of the Wart-hill; climbed it, by a steep ascent; and then descended, across a desolate tract, to the edge of a lofty precipice, overhanging the sea. Before us, at but a few yards distance, *and probably detached from the coast, by the action of the impetuous sea* upon the soft red sandstone, appeared the noble column, called 'the Old Man of Hoy,' rising to the height of twelve or fifteen hundred feet*."

The following is a sketch of a very similar scene, from a similar cause: it represents the pillars called "*Dunscaby Stacks*," on the coast of Caithness; and the more distant point shows the smooth form of the land, and the manner of its decay, to be exactly similar to what has already been described.



Dunscaby Stacks, in Caithness.

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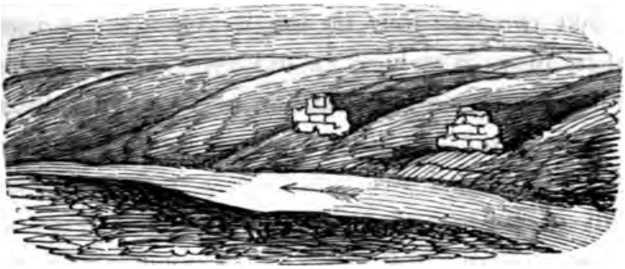
* *Saturday Magazine*, August 1835.

It is scarcely necessary to remark, that the western coasts of our island also present numerous fine examples of the action we are now considering. But parts of these western shores being in some degree protected from the vast swell of the Atlantic, by the position of Ireland, the finest examples of sea cliffs are found, as we might anticipate, on the coasts of Wales and Cornwall. On the west of Ireland, exposed as it is to the prevailing western gales, and to the consequent rolling in of a terrific swell, from the Atlantic, we have an endless succession of splendid coast scenes, from Kinsale, round to the Bay of Galway, and also on the coasts of Connaught. It is to this action of the sea alone, that we owe the disclosure of two of the most splendid known instances of basaltic structure: that of the Giant's Causeway, in the county of Antrim, and of Fingal's Cave, on the opposite coast of the Isle of Staffa. There can be no doubt, that the formation, of which they are parts, is not confined to these two localities; some have even supposed that it is continuous, between the two shores. Be this as it may, had there been *no action*, there could have been *no cliffs;* and a time certainly once was, when these fine instances of the prismatic crystallization of what was probably, like all basalt, *a submarine lava, suddenly cooled,* by the lower temperature of the sea, into which it was projected, were not displayed to view, as we now see them; but were covered up, and smoothed off on the surface, as they still are, where yet untouched by the corroding action of the waves.

Thus, we find a perfect similarity in the forms of the sea cliffs on the British coast, whether they are composed of *blue clay*, as in Sheppey; of *chalk*, as in Kent, Sussex, &c.; of the *carboniferous rocks*, as on the coasts of Durham and Northumberland; or of transition *schists*, and finally, of *granite*, as in the southern counties of Scotland, and in Aberdeenshire. The superficial forms of the country, are, in all these cases, equally smooth and rounded, when viewed on a great scale. The valleys are also invariably marked with the very same general features; and, in all cases, they present the same unequivocal proofs both of *aqueous*, and *simultaneous* origin. But although, in Britain, we find many beautiful examples of all the phenomena of valleys which have been described, yet the limited extent of the country, compared with its elevation above the sea, and the consequent rapidity of many of the slopes, has often occasioned a less obviously pronounced form, in the valleys, than is to be found on the more extended scale of France and Germany. From England, therefore, we may once more proceed to cast a glance over these countries; in the full conviction, that if we can extend the proofs above described, from our smaller models, to these great originals, we may confidently apply the subject to the entire surface of the dry lands of the earth.

The valley of the Seine has, more than once, been alluded to, as a specimen which cannot, in these respects, be surpassed for interest and for beauty. In its first and most elevated parts, it is grooved through the *older* rocks. It then enters upon the *oolitic strata;* and, in the basin of Paris, *it exhibits precisely similar forms,* while passing through channels cut in the *tertiary beds.* It then again enters upon the *secondary* strata, and is finally brought to a termination *on the exact level of the sea,* at Havre, after a winding course of *several hundreds of miles.* Now, it is vain for the geologist, resident upon the inland parts of such a valley, to hope ever to arrive at *a definite date,* for the formation of this beautiful combination of inclined planes. He may perceive, it is true, in the harmony of all its parts, proofs of *contemporaneous* origin; he may feel confident, while contemplating the universally winding forms of the valleys, and the exact *descending order* of the levels at which they join each other, that no system of *fracture,* (or of consequent *fissures,*) with which he is acquainted, will, in the least degree, correspond with the phenomena under his inspection. He will find every thing to militate against such an idea; for as, at the mouths of the smaller side valleys, he will perceive that the solid rocks are cut *exactly to the proper level,* and never present the appearance of a fissure, deeper than is visible to the eye, he will be struck with the *improbability,* not to say the *impossibility,* of such an extensive combination of *fortuitous* fracture; and will be led to reject a theory, which may be thus conclusively disproved. Of all this, the inland student may possibly become convinced; and he may further perceive, by the phenomena of *dry* valleys, that if an aqueous agent has been the cause of all valleys, *that agency is not now to be found in nature;* and, consequently, that the present grooved surface of the dry lands, has been imprinted upon them, *by some vast and unusual aqueous catastrophe.*

But though all this may be discovered, in the inland parts of a district, our geologist has still no data on which to argue, in proof of the *actual date* of such catastrophe: for as he sees that valleys have not been in the least degree changed, by the flowing even of the most powerful streams, during the last three or four thousand years, the present system may have been in existence for a hundred thousand, or even for a million of years. A waterfall, it is true, if seen in a proper light, might lead him to doubt such vast antiquity, from the very small result of its incessant labours. But it is *on the sea coast* alone, at the mouth of some such great system of valleys as that of the Seine, that *the precise date of its origin,* can possibly be unfolded. For this purpose, let us follow our inquirer, for a few moments, in his view of the lower parts of the valley of the Seine. From Rouen down to Havre, he finds at every turn of the valley, such marks of aqueous agency, as have been already fully described at page 126. He sees the banks beautifully rounded off, except at the alternate angles of these windings, where the appearance of a *precipitous bank* on one hand, and a *smooth slope* on the other, follows with almost as much regularity as the night the day. He sees in the quarries which, in many parts, abound, conclusive proofs in opposition to the theory of fissures, in *the horizontal lines of the undisturbed strata, on both sides of the valley.* In two or three rare instances, in this valley, (the only ones that I have chanced to meet with, in an extensive scrutiny into the subject,) he finds further proof of its having been grooved out *by water, from a continuous and solid mass,* in such appearances as are seen in the following sketch from nature.



Projections, on the smooth side of the Valley of the Seine.

He there finds, that while the generality of the valleys around, are of the smoothest forms, two points of rock, more compact, perhaps, than the rest, have resisted, and withstood the current; and are now seen projecting, on the side of the hill, with their upper parts rounded off in a manner which nothing but water could possibly have occasioned. On proceeding towards Havre, he at length reaches the open *embouchure* of the river, where it approaches the sea, and where there is sufficient breadth to occasion considerable roughness, during certain winds. He there, *for the first time*, perceives, that *small precipices*, or *cliffs*, interrupt that general smoothness, which he had hitherto remarked in the inland parts of the valley. *These are not, however, universal;* it is only on such projecting points as are exposed to the surf, that such cliffs are found. He naturally concludes, that this is a *modern*, and *mechanical* change, and that such was not the original form of the land. On reaching Havre, and walking up to that fine point, where the two lighthouses have been built, he sees, perhaps for the first time, specimens of sea cliffs, on the largest scale of that coast; and finds so obvious a *cause*, in the restless waters below, with great masses of the rock, falling down, from time to time, that he can no longer doubt, as to great changes being now in progress, wherever the lands are exposed to this action of the sea. In returning towards the town, he finds, however, that the sides of the *côte*, (or hill overlooking the Port,) soon retire beyond the reach of this invading force; and instantly exhibit, *in an entire state*, those original and smooth forms, with which he was already so well acquainted. The conclusion instantly follows, that if so little damage has as yet been done, by an action which is *incessant*, *its commencement cannot be remote;* and that *before that commencement*, the sides of the valley were as entire at its mouth, as throughout the hundreds of miles of its course, which he had before examined. A more mature study, conducts him to the results already described, and distinctly indicates an age of but *a very few thousands of years.* He now readily perceives, that there must be a complete identity, between the period when the smooth sides of the valley were left *in a complete state,* and when that violent friction was *begun,* which occasions sea-cliffs. He is thus led to a particular, and very recent date, which will constantly recur to his mind, on returning to his inland valleys, even at points the most remote from the sea. The film which, before, obscured his sight, has been removed; and whenever a subsequent difficulty arises, as to the phenomena even of Alpine valleys, his thoughts return, with the velocity of lightning, along the windings of the rivers, to that interesting index *at their mouth,* which the sea coast alone presents*.

There can be no doubt that many interesting facts which could be brought to bear, with conclusive force, upon our present argument, might be established on the French coast, with regard to the exact rate of decay. These require more time and consideration, however, than I have, as yet, been able to bestow upon them. But there is one highly interesting instance, which I shall mention here, in proof of the decay of the coast, during the last eighteen centuries. In the neighbourhood of Boulogne, the lands present the same smooth and sloping forms, which are seen throughout nearly the whole of the kingdom. The valleys are generally *dry;* and those occupied by small streams, terminate, as usual, in the sea, with that regularity of corresponding levels, which has already been described. A little to the east of the harbour of Boulogne, are still to be seen a few remains of the foundation of an ancient Roman building, now on the very verge of the cliff, and which will disappear in the course of a few years more. This was the ancient *pharos,* or light-house, erected by the Emperor Caligula, during his short campaign in Gaul, to commemorate his boasted conquest *over the ocean.* During sixteen centuries, this building stood, in good preservation; but the blue lias, of which that coast consists, being extremely liable to decay, the waves made a gradual and steady encroachment, upon the elevated slope on which it had been built; and on the 29th of July 1644, this ancient tower was precipitated over the cliff. It had been enclosed with a wall, for some space around it; and all that remains, at the present time (1836), are the last vestiges of this enclosure.

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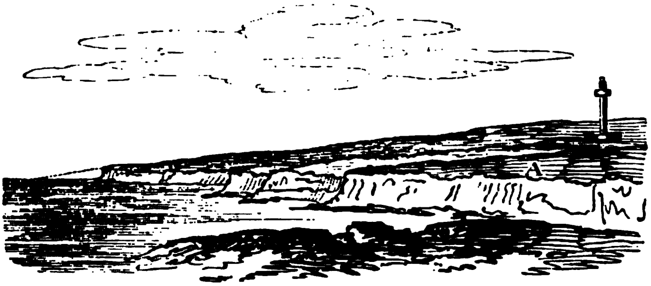
* This interesting subject only requires to be studied *from nature,* to be fully appreciated, and understood. It may, however, be well, to caution those who are desirous of candidly examining its evidences, against attempting the study, *for the first time,* from the mountains *downwards.* The student should first firmly ground his premises, on the sea coasts, and in the valleys of the lower country, and of the softer formations. He will then find, as he follows up the thread of these valleys towards the hills, that he cannot avoid carrying his first conclusions along with him; and he thus finds himself forced to attribute the whole system, *to a similar and simultaneous cause.*

Now we have, in this instance, a well authenticated fact, which clearly speaks to a period of eighteen centuries; and on regarding the superficies of the whole of that coast, we perceive the outline of the promontory called the *Brun Nez*, to the east of the harbour, tending towards the surface of the sea, in a low slope, which would touch that level *in about a mile of distance*, a little less or more. The ground on which this Roman lighthouse was built, has an exactly similar slope, which is also extended inland. We may, therefore, conclude that about *one mile* is the real amount of loss, from that coast, since the period when its superficial forms touched the surface of the waters, in an unbroken state.



Coast, to the eastward of Boulogne harbour.

In the above sketch, the remains of this ancient building, are to be seen at the point A.

Now, although we have not in this instance, distinct data, on which to calculate a definite period, as the age of the dry lands on this coast, yet we may draw most instructive conclusions, from such facts as we possess, with regard to this Roman *pharos*. We cannot now say, at what distance from the cliff of that period, the Romans constructed their work; but from what we know of the care and judgment bestowed upon such subjects, by the ancients, we may be assured that the action of the sea was not lost sight of, as it must have been still more destructive on the *lower* cliffs of that day, than it has ever since been. As we cannot extend the original outline of the coast, further than about a mile beyond the present cliffs, (or sixty-three thousand, three hundred and sixty inches;) and as we know, with equal certainty, that no change of level between sea and land, has occurred, during the four thousand years of the historic period; we shall thus have an average loss, during the whole of that time, of about sixteen inches *per annum;* the early periods giving much *more*, and the later much *less*, than that medium, on the principle which has been already fully explained at page 231. Now, if we suppose a longer period, (for example, ten thousand years,) we shall have an average loss, of only *about six inches and a half*, *per annum*, which is evidently too little, for this soft lias formation; and we thus find ourselves strictly circumscribed, both as to the limits of *time* and *space*. As the tower fell about two hundred years ago, and as parts of the enclosure are still to be seen, on the verge of the cliff, we have some slight indication of the rate of the decay, as we cannot suppose that enclosure to have been of any very great extent. Of that mile, then, which has already disappeared, we may conclude that more than *a half* was already gone, in the days of Caligula; and that, with this progressive decay in view, his architects would not have founded this monument of his triumph over the ocean, at less than a quarter of a mile from the verge of the cliff. At little more than this distance inland, we now see that splendid monument of an equally empty boast, which was erected by Napoleon, to commemorate his expected triumph over Britain. It is not probable that it will stand for a much longer period, as the slope of the ground is not great between it and the cliff, and the decay will, therefore, continue nearly at the same rate that it now does*.

Here, then, we are led, at the mouths of the valleys of France, to the same conclusions which we have attained, in our three smaller models, and throughout the whole coasts of Britain. We find distinct demonstrations of the original forms of the lands, *at the period of their elevation above the level of the sea;* and we cannot study the existing action of the waves without perceiving, that, beyond the historic periods, consisting of but a few thousands of years, we cannot bend these facts. The least attempt to extend the period, even so little as to ten thousand years, at once destroys that beautiful harmony which prevails, in the phenomena which we have now been considering*. It is unnecessary to press this subject further, with regard to the European continent: for if the sea-cliffs of France attest the period, when the valleys of that country were all adjusted to each other, as we now see them, and by a power which we no longer behold in nature, we are led, by the same evidences, to the very summits of the Alps; *and, consequently, to the very birth of the whole existing continents,* both of Europe and of Asia, in their present character of dry lands. Of Africa we cannot now judge, except from analogy. But that law of analogy becomes almost conclusive, when we also find in the midst of the American continent, a chronological index in Niagara, which cannot consistently be forced to point, beyond a like period of only *four or five thousand years!*

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* Amongst other fixed points on the coasts, where the present distances might be marked, for the information of future inquirers, there could not be one more proper than this column of Buonaparte, near Boulogne. The North Foreland lighthouse is also a good fixed point, upon our own shores.

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* Dr. Chalmers has well remarked, in his *Bridgewater Treatise* (Vol. II., p. 190), that "there is a stubbornness in *facts*, before which the specious ingenuity is compelled to give way; and, perhaps, the mind never suffers more painful laceration, than when, after having vainly attempted *to force nature* into compliance with her own splendid generalizations, she, on the appearance of some rebellious and impracticable phenomenon, has to practise a force upon herself, and when she thus finds the goodly speculation superseded by the homely and unwelcome experience."

There can be no doubt that the coasts of that continent will also be found, on inspection, to indicate a definite period, if examined at points which bear a *smooth*, a *solid*, and a *sloping* character. Without the presence of this latter form, however, we can come to no distinct conclusion; and from the prevailing flatness of the American lands near the sea, the absence of this may, in many places, prove an insuperable obstacle to any definite calculation*. It must also be remembered that, in such countries as America, no dependance ought to be placed on coasts of an *alluvial* character. Nothing but *solid rocks*, and distinct formations, can be depended upon as conclusive, in this argument. It has, indeed, frequently been objected to this fact of the retrogression of sea-cliffs, that instead of *loss*,

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* In a volume of the *New Monthly Magazine* for 1822, we find the following statement, which was probably copied from some American journal. I cannot, of course, vouch for its correctness; but, from the exposed situation of Cape May, we can readily credit the amount of loss. "At Cape May, where the Delaware falls into the Atlantic, the following curious observations are inscribed on the wall of a house:

Distance of this house from the sea.

	feet.		feet.		feet.
1804.........	334	1809.........	267	1817.........	214
1806.........	324	1811.........	259	1818.........	204
1807.........	294	1812.........	254	1819.........	188
1808.........	273	1816.........	225	1820.........	180

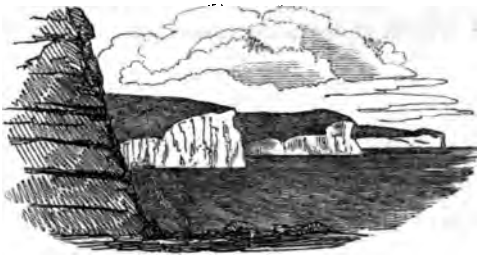
The total loss, in sixteen years, is one hundred and fifty-four feet, or nearly ten feet per annum, which probably bespeaks an earthy shore.

there is, in some countries, an *accession* of land, by the sea's action. This is true, as to alluvial lands, such as Holland, and other low countries; but no addition can, by possibility, take place, *in solid rocks*, where the cliffs must uniformly *retrograde;* and on such alone, ought an argument to be founded. In the absence, however, of further proofs, as to the American sea-coasts, it is interesting to catch such glimpses of the same general truth, as are afforded, in the most distant and remote latitudes. Thus, in Captain Back's interesting journal of his last expedition, in search of Captain Ross, he describes, at page 388, a promontory, which he has called "Victoria Headland," and of which he gives a view, from which the following sketch is taken.

Victoria Headland, in the Arctic Regions.

He says, "the river *Thlew-ee-choh* here falls into the sea, after a violent and tortuous course, of five hundred and thirty geographical miles, through an iron-ribbed country, without one single tree on the whole line of its banks." The moment he approached its mouth, however, where its banks became subject to the restless action of the waves, he perceived *cliffs*, such as were no where to be met with inland; and though he found the navigation of that river frequently interrupted by falls and rapids, yet we cannot fail to perceive, in his descriptions of the country, and of the innumerable tributaries which fall into that stream, the very same general characteristics which other rivers present, when their valleys are grooved out from the older and more refractory formations of rocks. We see, at the mouth of this remote river, the very same smooth and rounded superficial forms, which our own coasts exhibit; and though we cannot actually measure their angles, and thus compute their rate of decay, we may conclude by analogy, from their appearance, that they would lead us to the very same period as Niagara, and our own sea-cliffs, have done.

I have lately met with another interesting sketch, from a different quarter of the world, and of which the following is a copy. It appeared in the *Saturday*



Headlands, on the coast of New South Wales.

Magazine for January last, (1837), and represents some headlands, on the coast of New South Wales, between Port Jackson, and Broken Bay. The object of the sketch, was not so much for the purpose of representing the coast, as the mode of fishing, practised by its natives; but no one who has attentively pursued the line of argument, over which we have just passed, can fail to be struck with the perfect similarity of these headlands, to those of our own European coasts. It is true, we have not here so well-defined *a superficial slope* towards the surface of the water, as in the sketches already given; but we see plainly that the cliffs *become lower, towards the interior of the bays;* and we cannot doubt that points must be found, a very little more inland, where the slopes are yet *untouched,* and consequently as perfect as those to be seen on the sheltered sides of our *model* islands. Thus, we have reason to conclude, that such facts as have now been described, are general, over the whole face of the present dry lands of the earth; and we may, therefore, with safety, found upon them, such general conclusions as thus become, in a manner, unavoidable, and which it now becomes our duty more fully to consider.

CHAPTER IX.

ORIGINALITY AND NOVELTY OF THE FACTS ALREADY DETAILED IN THIS TREATISE. A GENERAL SUMMARY OF THESE FACTS, AND OF THE INFERENCES WHICH NATURALLY FLOW FROM THEM.

Having thus passed under our review, the whole series of facts which it has been the chief object of this Treatise to describe, it now becomes necessary that we take a more summary view of the subject, generally, in order that we may become fully aware of the consequences of these new facts, as they bear upon those theories of geology, which are at present the most popular. And first, it may be permitted me to show, that I am fully justified in applying to these facts, the character of *novelty;* for though various writers have touched upon some of them, during the short existence of the geological controversy, the inferences drawn from them appear always to have been distorted from that line of simple truth which now seems so glaring, either by an anxious desire to support some favourite theory, or to refute some opposing one.

Thus we find that Hutton, in the midst of those unbounded ideas which his celebrated theory unfolds, had taken a very correct view of the forms of valleys, of their combinations one with another, and of *water* being the only agent, by which they could have been excavated. This philosopher says, "In the economy of the world, I can find no traces of *a beginning*, no prospect of *an end*." His theory of the earth, is expressed in the following short passage:—"The ruins of an older world are visible in the present structure of our planet; and the strata which now compose our continents, have been once beneath the sea, and were formed out of the waste of pre-existing continents. The same forces are still destroying, by chemical decomposition, or mechanical violence, even the hardest rocks, and transporting the materials to the sea, where they are spread out, and form strata analogous to those of more ancient date. Although loosely deposited along the bottom of the ocean, they become afterwards altered and consolidated by volcanic heat, and then heaved up, fractured, and contorted." But Hutton, intent only on proving the vast antiquity of the earth, carried his sweeping conclusions far beyond the limits prescribed by his premises; and was thus amongst the first to mislead the scientific world into that tangled labyrinth, which most men now perceive, and which some regard without much hope of ultimate extrication.

Following under his guidance, we find his able disciple Playfair, thus illustrating the Huttonian theory, with regard to the slow destruction of the present earth, in preparation for those new systems, which he supposed to be in constant progress in the bed of the sea, and in that *vast furnace* which he imagined to exist in the bowels of our planet. "The general structure of valleys among mountains," says he, "is highly unfavourable to the notion, that they were produced by any single *great torrent,* which swept over the surface of the earth." At the period when this passage was written, there had been many attempts at a theory of a deluge; and the prevailing idea seems to have been, as it still too commonly is, that of *a great torrent, or wave, rushing in one particular direction,* over the *present* lands. As we have now found the means of attaching a recent date to valleys, agreeing as closely as can possibly be expected, to the great Historic change, termed "a Flood of Waters;" and as we do not see valleys all tending *in one particular direction,* but falling towards the sea *in all directions;* the idea of a transient *torrent* must give place to some more steady and orderly change, during which *the bed of the former ocean was elevated into dry lands, while the old lands were depressed, so as to form the new bed of the waters.* Mr. Playfair continues, "In some instances, valleys *diverge,* as it were, from a centre, in all directions. In others, they originate from a ridge, and proceed with equal depth and extent, on both sides of it; plainly indicating, that the force which produced them *was nothing, or evanescent,* at the summit of that ridge, and increasing on both sides, as the distance from the ridge increased." This is an admirable description of the true system of valleys; and distinctly invalidates the idea of any single rush of waters, *in one particular direction.* It is, in fact, a well drawn picture of the bed of a muddy harbour, at low water. The tide has deserted it, *in all directions,* in search of a lower level; and its systems of valleys " diverge, as it were from centres," and show " that the force which produced them was *nothing,* at the summits" of the soft and ductile heights. The conclusion of the passage is as follows:—" The working of water *collected from the rains and the snows,* and seeking its way from a higher to a lower level, *is the only cause we know of,* which is subject to this law*." Had the first words of this passage, which are printed in italics, been omitted, this description would have been entitled to command our deepest attention. The working of *water* can alone produce such effects; but it would require some more powerful body, *to mould a continent into valleys,* than such collections as are derived from *the rain and snow on the mountains.*

Mr. Playfair then considers the system of rivers, as follows:—" If we proceed in our survey," says he, " we meet at every step, with the fullest evidences of the same truths," (as he had been describing on the sea coasts,) "and particularly in the nature and economy of *rivers*. Every river appears to consist of a main trunk, fed from a variety of branches, *each running in a valley proportioned to its size*, and all of them together, forming a system of valleys, communicating with one another, *and having such a nice adjustment of their declivities*, that none of them join the principal valley either on too high or too low a level; a circumstance which would be infinitely improbable, if each of these valleys *were not the work of the stream that flows in it*."

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* *Illustrations of the Huttonian theory of the Earth,* by Professor Playfair.

Had Professor Playfair confined his conclusion to the fact, of *water* having been the cause of valleys, nothing could have been more clearly descriptive of those facts which have now passed under our consideration, than this passage of his "Illustrations." But he altogether overlooked the fact, *of* DRY *valleys having the same forms as those occupied by rivers;* and he went beyond the truth, in describing the tributaries as *always proportioned to the size of their streams*. He proceeds to take an enlarged view of the system of valleys; but is again led to that erroneous conclusion, which best suited the theory which he was occupied in illustrating. "If indeed," he continues, "a river consisted of a single stream, without branches, running in a straight valley, it might be supposed that some great concussion, *or some powerful torrent*, had opened, *at once*, the channel by which its waters are conducted to the ocean; but when the usual form of a river is considered, the trunk divided into many branches, *which rise at a great distance from one another,* and these, again, sub-divided into an infinity of small ramifications; it becomes strongly impressed upon the mind, that all these channels have been cut *by the waters themselves;* that they have been *slowly dug out,* by the washing and erosion of the land; and that it is *by the repeated touches of the same instrument,* that this curious assemblage of lines has been engraved so deeply on the surface of the ground*." Here again, this philosopher appears to have closed his eyes upon the fact of those innumerable *dry* tributaries, if I may so call them, which he could scarcely have failed to remark, in the course of forming so just an idea of the beauty and accordance, which he so well describes in valleys. He appears never to have studied those models of the system, already alluded to, as presented by the muddy basins of our harbours, when the tide has ebbed. Had he ever contemplated these miniature continents, with their "curious assemblage of lines engraved upon their surfaces," and occupied by mere *trickling rills*, in the absence of that *more powerful aqueous agency* by which they were grooved out, he never could have thus mistaken the mere *effect* for the *cause.*

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* The following passage will show, that parts of the Huttonian theory are not without an advocate, even in the present day:—

" Provided, therefore, we suppose the elevation and subsidence of mountain chains, to be a *gradual process*, there is no difficulty in explaining how *the rivers*, draining our continents, *have converted ravines into valleys*, and enlarged and deepened valleys to an enormous extent. On the contrary, the signs of slow and gradual action, so manifest in the sinuosities, and other characters of valleys, are admirably reconcileable with the great width and depth of the excavations, *if we are content not only to suppose a great succession of ordinary earthquakes, but also the usual intervals of time, between the shocks.*"—*Principles of Geology*, Vol. I., p. 498.

Such was the theory of Hutton and Playfair, on the subject of valleys; they had previously concluded that *the beginning* of the existing state of things could by no means be arrived at. They did not perceive, on the present dry lands, that most important and universal fact, (to which no writer, as far as I am aware, has ever before alluded) of *a smooth superficial slope on all hands towards* THE EXACT SURFACE *of the surrounding ocean;* and that unceasing action of the waves, *on the lower parts of that slope*, which point, with a certainty which cannot be avoided, *to* A PARTICULAR DAY, *when that action first began.* In like manner, were they blinded by their previous theory, with regard to *cliffs* and *water-falls.* Mr. Playfair, in the following passage, clearly depicts the existing action of the waters; but his object being PRO-*spective*, and to show the entire destruction which a continuance of such action would, *in time*, bring upon the lands, he steadily kept that very remote object in view; and neglected to observe, by one slight RETRO-*spective* glance, the *close vicinity* of *the commencement* of that action. He says, "It would far exceed the limits of this sketch, to pursue the *causes* of mineral decomposition, through all their forms. It is sufficient to remark, that the consequences of so many *minute,* but *indefatigable* agents, all working together, and having *gravity* in their favour, is a system of universal *decay* and *degradation,* which may be traced over the whole surface of the land, *from the mountain top to the sea shore.* That we may perceive the full evidences of this truth, *one of the most important in the natural history of the globe,* we should begin our survey from the latter of these stations, and retire gradually towards the former." Here this beautiful writer was perhaps as near the truth as a man can be, *without perceiving it.* His theory was that of *destruction;* a COMMENCEMENT was not the object he had in view. He thus proceeds: "If the coast is bold and rocky, it speaks a language easy to be interpreted. Its broken and *abrupt contour,* the deep gulphs and salient promontories, by which it is indented, *and the proportions which these bear, to the force of the waves,* combined with the inequality of hardness in the rocks, prove, *that the present line of the shore has been determined by the action of the sea.* The naked and precipitous cliffs which overhang the deep; the rocks hollowed and perforated, as they are further advanced in the sea, *and at last insulated,* lead to the same conclusion, and mark, very clearly, so many different stages of decay. It is true, we do not see the successive steps of this progress, exemplified in the same individual rock; but we see them clearly in different individuals; and the conviction thus produced, when the phenomena are sufficiently multiplied and varied, is as irresistible, as if we saw the changes effected, in the very moment of observation."

Now, we have, in this case, a complete example of that mixture of *truth and error*, so common in geological theories. Nothing can be more *true* than the above description of the facts—nothing can be more *erroneous* than the inferences which Mr. Playfair drew from them. Had he confined his view, to one country, and to one coast, *of a perfectly flat surface*, he could there perceive, it is admitted, no symptom of the *beginning* of this action of the sea; but in the difficulty of finding such a country, (for such scarcely any where exists,) he must probably have studied the coasts of our own island. Let us, for a moment, suppose him placed upon the summit of the abrupt and precipitous sea-cliffs, on the coast of Scotland, between Dunbar and Berwick, with which he was so well acquainted. From that point, looking *towards the sea*, he would perceive those effects which he has so beautifully and clearly described in the above passage. But on turning round *towards the land*, instead of abrupt precipices, he would find one *uninterrupted slope*, of the smoothest kind, over which he might have rode to the very heights of Lammermuir, at a distance of fifteen or twenty miles. Now, had the fact of *a superficial slope* once occurred to Mr. Playfair, or to Dr. Hutton, they were too well acquainted with the laws of just analogy, to argue upon an arbitrary and sudden *cessation* of that slope, merely because they could not *see* its continuance. Had it but once occurred to them, that, from an elevation of about *two thousand feet*, this slope was regular and *uninterrupted*, for a space of fifteen or twenty miles, they must have seen, as we now do, with the full force of demonstration, that it must formerly have been *continued;* and that, *as two lines cannot be extended, at different angles, without crossing*, the line of the slope, and the line of the sea's level, *must once have met;* and that *that* must necessarily have been the point, where the ceaseless action of the waves FIRST *broke into the smooth surface of its sloping shores.* We must not, however, attribute such want of perception to mere prejudice, or to wilful blindness. From that day to this, hundreds of other geologists have studied our coasts, with the structure and the positions of their rocky strata, and yet no gleam of this simple and pure light has been shed upon their minds. For years, I have myself been occupied in similar pursuits; I have admired the cliffs, have examined their internal structure, have done any thing *but* perceive this glaring and simple fact. But the instant it occurs to the mind, (like the easy solution of some enigma or puzzle, *when once explained,*) one is astonished that so obvious a fact should have so long escaped our observation; and the mind's eye is never tired with admiration of the effects, to which we are thus irresistibly conducted. If we may venture to compare small things to great, we feel, on the observation of these simple facts, and the happy combination of their results, somewhat of that mental satisfaction so beautifully described in the following passage, with reference to the more important discoveries of astronomy: "Let us consider, for a moment, what takes place in the mind of a student of nature, on attaining to the perception of a law previously unknown," (or of facts previously unobserved) "connecting the appearances which he has studied. A mass of facts which before seemed incoherent and unmeaning, assume, on a sudden, the aspect of connection and intelligible order." "The change is like that which takes place, when we attempt to read a sentence, written in difficult or imperfect characters. For a time, the separate parts appear to be disjointed and arbitrary marks; the suggestions of possible meanings, which succeed each other in the mind, fail, as fast as they are tried, in combining, or accounting for these symbols: but, at last, the true supposition occurs; some words are found to coincide with the meaning thus assumed; the whole line of letters appear to take definite shapes, *and to leap into their proper places;* and the truth of the happy conjecture seems to flash upon us, from every part of the inscription. The discovery of laws of nature," (or, as in the case before us, of new and important facts in nature,) "truly and satisfactorily connecting and explaining phenomena, of which, the connection and causes had been before unknown, displays much of a similar process; *of obscurity, succeeded by evidence; of effort and perplexity, followed by conviction and repose*[*]."

With regard to water-falls, the descriptions of Mr. Playfair, in his "Illustrations," present the same mixture of truth and error, before alluded to. "The smooth surface of the rocks in all water-falls," says he, "their rounded surface, and curious excavations, are the most satisfactory proofs of the *constant* attrition which they endure; and where the rocks are deeply intersected, these marks *often* reach to a great height above the level on which the waters now flow." We here naturally pause to consider why this should not *always* be the case; and why it is only "*to a great height*," and not invariably, to the *very tops* of the rocks. "The phenomena, in such instances, are among the arguments best calculated to remove all incredulity, respecting the waste which rivers have produced, and are continuing to produce. They suffer no doubt to remain, that the height and asperity of every water-fall are continually diminishing; that innumerable cataracts are entirely obliterated; that those which remain are verging towards the same end; and that the Falls of Montmorenci and Niagara, must ultimately disappear." In this instance also, Mr. Playfair's views being only PROSPECTIVE, his description is perfectly just. But he entirely failed to perceive such effects as have been described at Queenstown, in the case of Niagara, where, as the work must necessarily have been *commenced,* on that particular day *when the river* FIRST BEGAN *to flow,* he must have been irresistibly led, as we now are, to admit distinct proofs *of the beginning of existing things,* on that entire continent.

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[*] *Whewell's Bridgewater Treatise*, p. 305.

If such were the results of unbounded theory on the one hand, the arguments offered in opposition to them, were, on the other, often not less erroneous. De Luc, who wrote "An elementary Treatise on Geology," in opposition to the Huttonian theory, in denying the above inferences of Playfair, with respect to sea-cliffs, went as much too far, in an opposite course, and altogether denied to these cliffs, a marine origin. He says, "*It is not the sea which has produced the cliffs* on the shores of our continents; *they existed at the birth of the continents.* As long as the sea continues to be of a certain depth near the shores, it can act upon them, only by its waves; how, therefore, is it enabled, in some places, to impel against them, fragments of rocks?" (This was in reply to Playfair's observation, that the rocks already detached, became instruments of further destruction, by being again dashed against the cliffs.) "It is because there, the fragments having accumulated in the water, at the foot of the rocks, are now arrived at the level of the sea. The beach thus formed, receives the new fallen fragments; and the waves, assailing it with violence, continually propel the latest fragments towards the rocks, beneath which they form a slope, which may be seen at low water; and which, increasing gradually in height, is in time, discernible at high water also. There indeed, the fragments are ground against each other by the waves, and reduced to that gravel, which is impelled against the rocks: but, in proportion as new fragments fall, the beach becomes more elevated, till, at length, the waves can no longer reach the foot of the cliffs, *which by continual degradation, are, in time, reduced into slopes**."

The only remark that this passage demands, is, that it could not be the result of an attentive study of *nature*, on any extended sea coast. In some few places, and from *local* casues, such effects are occasionally seen; and one instance particularly occurs to my recollection, in one or two of the cliffs of Kent, near the South Foreland. On parts of the coast between Walmer and Dover, the cliffs have now become thus protected, by a vast accumulation of gravel. But such are the rare exceptions, and certainly not the general rule. It is a *local* effect, proceeding from a purely *local* cause.

In the phenomena of water-falls, De Luc was equally blinded by a desire to refute the Huttonian arguments of destruction, in unbounded periods of time. Instead of admitting the obvious fact, of rocks being worn away by cataracts, he only notices a fact, of not unfrequent occurrence, of a species of *moss*, growing on the edges of rocks, from which such waters flow. "I have observed this moss," says he, "in many places, *at the edge of rocks*, from which torrents fall, and *which they certainly do not injure* in their course. Even the great cataract of the Rhine, at Schaffhausen, exhibits the same appearance; the stream majestically pursues *its unruffled course*, over the brow of the rock, and begins to foam only at its foot, in consequence of the torrent dashing itself *against its own waters*."—(p. 157.) There would be but little *foam*, in this, or in any other case, if there were only *water* to dash against; and the terrific cry at sea, of "*breakers ahead!*" would not then be so appalling, to the tempest-driven mariner. Instances of such moss, are, no doubt, to be seen, in many water-falls; but it is only "where the stream pursues an *unruffled* course, over the brow of the rock." Nor will it, even then, prevent large masses of such rocks, with their mossy covering, from becoming detached, and being hurried down, bodily, by the torrent. Such are the obvious errors into which we are too often led, in the warmth of debate. And yet, notwithstanding this, and many such errors, De Luc had as clear a perception of *the very recent commencement* of our existing dry lands, as the nature of the facts then observed, could be expected to produce. From the limited extent of the *deltas* of rivers, where they open into lakes, he clearly saw the bounds, *beyond which* theory could not safely lead him. In reasoning on the excavations of valleys, by the long-continued action of the rivers which flow through them, Playfair perceived the great difficulty into which he was led, by that striking instance of the Rhone, which falls, from the *Vallais*, into the Lake of Geneva, which latter, though of great depth, ought, according to his theory, to have long since *been entirely filled up*, by the detritus with which that muddy river is always heavily charged; for it flows in *muddy*, and flows out *clear*, so that all its sediments are deposited in the lake, within a few miles of its mouth. De Luc clearly saw a necessary *commencement* of this action; and he thus replies to Playfair's unsatisfactory evasion of the difficulty; "With regard to the *commencement* of the existence of our continents, the chronometer mentioned by Mr. Playfair himself, at the entrance of the Rhone into the Lake of Geneva, accords, not only with every one of those found at the entrance of other lakes, but with all the different kinds of chronometers which I have pointed out, along the courses of rivers, and on the coasts; and, in general, with every effect which must have *begun to take place*, on our continents, *at their birth;* all these chronometers agreeing in their evidences, that our continents have not existed during any great number of ages*."—(p. 132.)

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* *Elementary Treatise*, p. 85.

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* "At the Delta of the Rhone, where it enters the Lake of Geneva, the ancient town called *Port Vallais*, was once on the water's edge, and is now more than a mile and a half inland.

The general reasoning is here faultless; but its effect was impaired by the obvious errors as to other facts, into which this author fell, in the course of his treatise. From the days of Playfair and De Luc, though much has been done towards the advancement of geology, with regard to its details, the evidences as to the question of *the commencement* of the present state of things, has remained nearly as they left them, with the advantage, on the side of the Huttonian theory, of its having been adopted in some of its wildest parts, by many of the most able geological writers of the present day.

The following reflections, from the pen of one who, amongst other branches of natural philosophy, was lately occupied in taking an unbiassed view of the

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This tract of land has been made *in about eight centuries*. The remainder of the Delta consists of a flat alluvial plain, *above five or six miles in length*, composed of sand and mud, a little raised above the level of the river, and full of marshes."—*Principles of Geology*, 2nd Edition, Book II., chap. 4.

We may here ask, can there be a plainer corroboration than this, of *the recent commencement* of the existing state of things in this grand Alpine valley? The Rhone *began to flow, on a certain day;* its muddy delta was also begun *on that day;* in eight hundred years, it has been extended *a mile and a half*, out of its entire length of *six or eight miles*. What then, was the state of things in Switzerland, immediately *before the Rhone began to flow;* and before its mud began to be deposited? Can we possibly apply an "*enormous period*, to this very limited effect?" or can we calculate on any analogy, within the scope of existing nature, to account for so recent a *commencement* of the present state of things, in these Alpine regions?

state of our geological knowledge, will, perhaps, best show the degree of novelty to which the main evidences now produced, may lay claim. Sir J. F. W. Herschell, in his "Discourse on the Study of Natural Philosophy," and while taking a view of this science, as compared with astronomy, gives a rapid glance at what seemed to him, the *obscure evidences of commencement and change,* which are displayed in the superficial strata of rocks. Speaking of fossils, he says; "These wrecks of a former state of nature, thus wonderfully preserved, (like ancient medals and inscriptions, in the ruins of an empire), afford a sort of *rude chronology,* by whose aid, the successive depositions of the strata in which they are found, may be marked out in epochs, more or less definitely terminated; and each characterised by some peculiarity, which enables us to recognise the deposits of any period, *in whatever part of the world they may be found.* And, so far as has been hitherto investigated, the *order* of succession, in which these deposits have been formed, *appears to have been the same, in every part of the globe.*"—(§ 317.) "In accounting for the changes that have occurred," (from sea to land,) "geologists have no longer recourse, as formerly, to causes purely hypothetical, such as the shifting of the earth's axis of rotation, bringing the sea to overflow the land,—by a change in the place of the longer and shorter diameters of the spheroidal figure,—nor to tides produced by the attraction of comets, suddenly approaching very near the earth,—nor to any other fanciful and arbitrarily assumed hypothesis; but rather endeavour to confine themselves to a careful consideration of causes evidently *in action at present,* with a view to ascertain how far *they,* in the first instance, are capable of accounting for the facts observed, *and thus legitimately bringing into view, as* RESIDUAL *phenomena, those effects which cannot be so accounted for.* When this shall have been in some measure accomplished, we shall be able to pronounce, with greater security than at present, respecting the necessity of admitting *a long succession of tremendous and ravaging catastrophes and cataclysms*—epochs of terrific confusion and violence,—which many geologists, (perhaps with justice,) regard as indispensable to the explanation of the existing features of the world. We shall learn to distinguish between the effects which require, for their production, the sudden application of convulsive and fracturing efforts, and those, probably less extensive changes, which may have been produced by forces equally, or more powerful, but acting with less irregularity, and so distributed over time, as to produce none of those *interregnums* of chaotic anarchy, which we are apt to think, (perhaps erroneously,) *great disfigurements* of an order so beautiful and harmonious as that of nature.

“ But to estimate justly the effects of causes now in action in geology, is no easy task. *There is, for instance, no* à priori, *or deductive process, by which we can estimate the amount of annual erosion of a* *continent,* by the action of meteoric agents, rain, wind, frost, &c. *nor the quantity of destruction produced on its coasts, by the direct violence of the sea;* nor the amount of lava thrown up, *per annum,* by volcanoes, over the whole surface of the earth, *nor any similar effect.* And to consult experience, on all such points, is a slow and painful process, if rightly gone into, and a very fallible one, if only partially executed. Much then, at present, must be left to *opinion,* and to that sort of clear-judging tact, which sometimes anticipates experience; but this ought not to stand in the way of our making every possible effort to obtain accurate information on such points, *by which alone,* geology can be rendered, if not an experimental science, at least a science of that kind of active observation, which forms the nearest approach to it, where actual experiment is impossible."—(§§. 320 and 321.)

Such were the judicious observations of this able astronomer, a very few years ago; and such as he describes it, was then the very limited state of our knowledge, with regard to the progress of meteoric and marine agencies, in constant action upon our dry lands. I may, perhaps, be permitted, without presumption, to hope, that the evidences just produced, from *sea-cliffs* and *water-falls,* have now become of a sufficiently distinct and definite nature, to entitle them to a place amongst such inductive reasonings, as are so beautifully applied to the more experimental sciences; and that, if we have thus, at length, been enabled to attain with certainty, a very recent date, (or even an approximation to such date,) as *the commencement* of the present state of things on the existing dry lands, we may thus be led to admit, that the great and entire change which must necessarily have occurred, between sea and land, *immediately previous to that commencement*, must be regarded as being now "legitimately brought into view, *as a* RESIDUAL *phenomenon, which the causes now in action cannot account for.*" We have not a shadow of testimony from past experience, during the historic periods, of any *natural* cause, bringing such an island as the Isle of Wight, from beneath the sea, to become a dry land, above its surface. All *natural* testimony is directly opposed to any such idea; for, as Cuvier has justly declared, "we can fairly judge of what *may have been*, only by what we know *has actually taken place.*" Every thing beyond this is pure hypothesis. If, then, the Isle of Wight may be regarded as a complete model of an entire continent, both as to its elevation, and the variety of its interior structure, we are still more forcibly led to a similar conclusion, in the case of the elevation of the continents, and larger islands of the world. They have all, it is universally admitted, once been *beneath the waters;* they are now elevated above them; and our varied chain of evidence shows an exact accordance, between the lands of the Old World and those of the New, as to the period of this elevation. It was therefore, by means of a great and *simultaneous* change, for which we find no counterpart in the regular order of nature.

Having thus justified the character of *novelty*, as applied to the facts of *sea-cliffs* and *water-falls*, which have now been, for the first time, brought forward in a new light, let us proceed in our proposed summary of the evidences which have now been adduced.

1*st*.—We find, by an extended view of the systems of valleys, over the whole earth, that they form groups, and combinations of inland drainage, falling, *in all directions*, from the summit levels of the dry lands, of whatever degree of elevation, to *the exact level* of the present sea. This reminds us of precisely such facts, as are seen, on a small scale, in nature; and leads directly to the inference which Hutton and Playfair drew from them, *viz.* that valleys unquestionably owed their origin to *water*. We here find cause, however, for diverging from the Huttonian theory, on this point: for, instead of supposing with these philosophers, that the *water* here spoken of, was that of *existing rivers*, working out their own channels, during immense periods of time, we are led to a totally different conclusion, by the innumerable *dry valleys*, which equally accord in their levels, with the rest of the system; and which distinctly prove, that *the agent by which these grooves were* *scooped out, is no longer to be seen on the surface of our continents.*

2nd.—We find further testimony to this *aqueous* agency, in the fact of the side valleys falling into *inland lakes*, being all hollowed out, (whether dry or otherwise,) *to the exact level of such lakes, respectively*, as the larger drains are, to that of the ocean. In this particular, these *lake tributaries* differ materially from the universal character of *river tributaries*, which latter join a central inclined plane, on both sides, each valley *at its own proper level*, as Playfair has justly remarked, in proving an aqueous agency.

3rd.—We find, in these facts, the clearest testimony in proof of the whole system having been *simultaneously* formed; for we perceive no pause nor check, in descending from the highest Alpine summits, down to the very level of the sea, in which all main valleys, whether of *one mile*, or of *one thousand miles*, in length, finally terminate.

4th.—Having proved that valleys cannot have owed their origin to the streams which now flow through them; and that, on the contrary, the streams originating in the condensed atmospheric vapours, naturally pursued, at their birth, such courses *as they already found prepared for them;* we are next led to the consideration of such abrading action as they have ever since exercised, at every rocky impediment, over which they have been forced to leap. We have seen that, in almost all well defined water-falls, the amount of loss can be shown to be but small; and that they, consequently, oppose, in the strongest manner, the theory of immense periods of time. But, at Niagara, we have found such a combination of immense *power* in the agent, and of *weakness* in the resisting body, together with so singular and complete a corresponding link, in the superficial form of the continent, that we are irresistibly forced to a point, in *space*, beyond which, the evidences of this action *suddenly cease to conduct us;* and we are compelled to admit the fact of that *commencement*, which De Luc more dimly perceived; which Hutton and Playfair overlooked or rejected; and which has hitherto escaped the notice of all subsequent writers on geology.

5th.—From this point, *in space,* we are next called to the consideration of an equally definable point, *in time,* to which these phenomena irresistibly conduct us. For as the cataract of Niagara is evidently working, at a certain rate, in a hundred years; and as the distance from its present site, is only about *seven miles,* to the point where this natural *saw* must necessarily have been first set in motion;

we cannot avoid arriving at *a definite period*, for that interesting event. The widest calculations do not lead to a period of more than about *ten thousand years*, as the duration of this ceaseless action; and we have shown, that, as the agent has been of *equal power*, while the resisting body has been, *by one half weaker* than it now is, we must necessarily reduce that period in proportion, to only about one-half that time; that is, to a period of *about four or five thousand years.*

6th.—Considering that the waters of Niagara compose the drainage of fully one-half the breadth of the North American continent; and that all the other systems and groups of rivers of the New World, are exactly similar, (with the exception of this great natural chronometer;) we are led, by fair analogy, to similar conclusions with regard to them, even in the absence of similar proofs; and we thus find, that as the *birth* of every river must have taken place, *from the very first day that the lands became elevated above the ocean*, (under which, we know, from the strata, and their fossil contents, that they once were;) and as the operation of Niagara also began, at Queenstown, *on that same day*, when the shallow basin of Lake Erie *first* overflowed its margin; we are thus led, by all the laws of inductive reasoning, *to the origin of the whole*

American continent, as a dry land, at a period not more remote than about four or five thousand years.

7th.—From this branch of evidence, we next come to a still more conclusive chain of testimony, afforded by the sea coasts, in every land. We have there, at length, perceived the glaring fact, which has so long escaped attention, *that the superficial forms of all lands, have an inclination towards the level of the ocean;* and that, on the known principle of two lines inevitably *crossing* each other, if extended at different angles, this sloping line of the land, *invariably touches the horizontal line of the sea,* at but a very small distance from the base of the present cliffs.

8th.—Hence we are again led to an unavoidable period of *commencement.* For as the action of the restless surge, is, to the sea coasts, what that of Niagara is, to its rocky channel, *namely, ceaseless* and *destructive;* we altogether lose sight of the *possibility* of this marine action, at the exact point, *beyond* that where the superficial outlines of sea and land come in contact. There, the *first* waves broke upon the new-born land, *on a certain day;* since that time, they have never ceased advancing upon the shore; and as the dry lands all slope *upwards,* while the level of the sea continues the same, the cliffs necessarily become every year *higher,* and so they must continue to do. But while this is going on before our eyes, we are brought to a complete pause, *beyond the above point of contact.* We know that ever since wind and water have existed, there must have been *waves;* we know and see the destructive effect of such waves; but beyond this point of contact, *there could be no destruction,* simply *because there was no land for waves to break upon.* The present lands, then, rose into existence, above the level of the waters, (or that level was depressed, which comes to the same thing,) *at a certain definite period;* and since that period, when a point of resistance was first offered to the waves, these latter have never ceased to bite into the shores.

9th.—The results of many observations, on the sea coasts of France and England, lead to the conclusion, that *not more than from a few hundred yards, to a mile,* have been already worn from the sloping lands. In a few remarkable cases, of low and soft shores, (as in Norfolk, Suffolk, &c.) the loss may be a little more than a mile; but the general average of loss may be stated, at but *half a mile,* or *eight hundred and eighty yards.* This space, (or thirty-one thousand, six hundred and eighty inches,) if divided over a period of ten thousand years, gives *an ave-*

rage annual loss, of only about *three inches,* which is evidently too little to correspond with the amount of loss which we now see in progress. We are, therefore, under the imperative necessity of greatly diminishing the period; and we are thus forcibly led to some point, between the historic times, and the above ten thousand years.

10*th.*—Nearer than this to the truth, we cannot at present come, nor indeed is it necessary. But as such evidences are to be seen throughout all our sea coasts, without exception; and as we thus establish innumerable indexes, where *cause* and *effect* are in complete and invariable accordance; the whole indicating the birth of our European lands, *at the very same period* with that which Niagara points out, as the origin of the New World, we thus form a chain of corresponding testimony, such as, perhaps, cannot be surpassed in any branch of science; and prove to demonstration, not only the long denied fact of a *commencement* to the present system of things, but also the very *recent* period of that commencement.

These new proofs fully confirm what had been before only supposed *probable;* for there are several points in existing nature, which also distinctly point to some such conclusion, though with a less commanding influence. Of these minor proofs, that so fairly dwelt upon by De Luc, of the very limited extent of the *deltas of muddy rivers* flowing into clear lakes, and there quietly depositing their sediments, is one of the most striking; and was, of itself, fully sufficient to show the erroneous nature of the Huttonian theory, as to the ceaseless action of the common course of nature. We have, next, the fact of *the thinness of vegetable soils*, even in the most luxuriant tropical forests, compared with the ceaseless annual decomposition of their abundant vegetable productions*. In like manner, we have the admittedly *recent*, but yet very limited, growth of peat, of which instances are recorded in England, where a depth of eighteen or twenty feet, has been known to overspread roads which we know to have been of Roman construction; and which peat *invariably covers the diluvial deposits,* instead of being, like all other formations, *overspread by them.* To these we may add, the not less conclusive fact, *of stalactite, in limestone caverns,* which, though still supposed to be slowly and constantly increasing, has, as yet, made but little progress in filling up cavities, frequently of no great extent*. All these natural operations, distinctly point to a period of *commencement;* but they by no means speak so plain and intelligible a language, as the forms of the *solid rocks* of the earth, and their ceaseless erosion, by mechanical agencies, which are now placed so completely within our observation.

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* "In estimating the quality of new lands in America," says Dr. Dwight, "errors are very commonly entertained, from the want of due attention to the following fact:—Wherever the forests have been *undisturbed by fire*, they have accumulated, *by shedding their foliage through a long succession of ages, and by their own decay*, a covering of *vegetable mould*, from six to twelve *inches* deep, and sometimes even *from eighteen to twenty-four*."—*Stuart's America*, Vol. I., p. 263.

This writer then proceeds to show, that too much value has often been set upon this vegetable manure, without considering what is the nature of the soil *below*; and that as the enriching effects of this vegetable mould soon vanish, on exposure and on tillage, the settler must finally depend upon the quality of the *natural soil*. It is to the very trifling depth of this vegetable accumulation in situations, which must have been forest, ever since these dry lands existed, that I am desirous of drawing the attention of the reader.

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* It is highly probable that the formation of *stalactite* and *stalagmite* in limestone caverns, if yet in progress at all, is not now so rapid as it was, when these cavities were first freed from the general aqueous covering of the dry lands, of which we have now adduced proof. My opinion is grounded on the fact, that but little or no change, or increase, has been observed, in the stalactite of some of the most remarkable caverns, by guides who have known them for a great many years. This opinion is also greatly strengthened by a fact which came under my own observation in Germany in 1834, on visiting a new bone cave, which had just been discovered near Erpfingen, in Wurtemberg. There were the clearest proofs in this cavern, that its very narrow and only entrance, had long since been *artificially* closed up, after having been occasionally visited by human beings. The floor was almost entirely covered with stalagmite, in the usual mammillated forms; and in the interior of the cave, were found the fossil bones of various species of animals, which have been most judiciously left in their stony matrix of stalagmite, and which may still be seen embedded in it, to a greater or less degree, as if a thick and pretty rapid formation of this calcareous substance had flowed in *among the bones, soon after their deposition there,* and had entirely ceased, after a certain *short period.* Had this *cessation* not taken place long since, it is very plain that we could no longer have obtained a sight of the bones, which, however, are still seen, partially deposited, as if in petrified mud, but which was not deep enough to

Having thus, under the above ten general heads, recapitulated the leading points of our argument

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cover them; and yet the roof above them, is hung with fine stalactites, with water constantly dropping from them, upon the rounded masses below. This water is usually considered to be still highly charged with calcareous matter; but in this instance, it is plain, that *for some thousands of years past*, no addition has been made to the stalagmite. If the fossil bones, *yet protruding*, were not sufficient proof of this fact, we have other conclusive evidence of there having been no increase, *for at least one thousand five hundred years;* for in one part of this interesting cave, *a fire* had been made, in a little hollow of the stalagmite, by some ancient inhabitant, or casual passenger seeking shelter. The charred wood was still seen in its place; the blackness of smoke has tinged the stone; and yet, though water constantly drops from the roof above, not the thinnest coat of stalagmite has been added since that fire was kindled. We now come to the proof of the period when that probably took place. Around this fire, (which had evidently been but little used, and was quite temporary,) lay, on other parts of the stalagmite, *broken earthen vessels*, *copper and iron rings*, *&c.* The vessels had the forms and structure of those commonly known as Roman; and on one of them was this distinct inscription SUAD. INV., which may probably be translated '*Suadonius*,' or '*Suadius invenit.*' Now as we cannot suppose that the Romans had any traffic in that part of Germany, later than one thousand five hundred years ago, or more, we may fairly infer, that no stalagmite has been formed in that cave, during that from facts, entirely independent of either history or tradition, it would seem an insult to the sense and judgment of every candid and intelligent reader who believes these facts, to attempt to prove to him by any further arguments, the obvious, and close connection between this *commencement* in the existing state of things, and that great and universal aqueous catastrophe, recorded by History, and more dimly indicated by an almost universal Tradition, in every part of the globe. For while these latter unequivocally speak of a *flood of waters*, destroying, but a few thousand years ago, the old dry lands, together

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period; and as the *half* embedded state of the fossil bones in the distant crevices of the cave, proclaim the same fact, during a much longer period, we have here strong ground for believing, that almost all such calcareous *drippings*, possessed a stony character *only in the early periods* of the existence of such caves above the waters; and, consequently, that there is an intimate connection, as to *time*, between the following three facts:—

1st.—Of the cave becoming a *dry* cavern, above the waters;

2nd.—Of the deposition of the fossil bones in it; and

3rd.—Of these bones becoming *partially* covered by the calcareous dripping which *at first* exuded abundantly from the limestone, and which is now known by the terms stalagmite, and stalactite.

The water which now constantly drops from these stalactites, is probably *a mere condensation of the atmospheric air*, on the cold roof; and we see the same process on a small scale, in the arches of cellars or bridges, when small stalactites have been formed from the new mortar, within the first year or two; but which never afterwards increase, *though generally exhibiting a drop of clear water.*

with their inhabitants, both brute and human; we find the former bearing still more decisive testimony to a great aqueous change having recently taken place, in which the bed of a former ocean was converted into a new dry land; and at which exact period, (corresponding with the Flood so nearly as to date, as to make their identity unquestionable,) all those *natural machines* which we now see in ceaseless activity, can be shown to have *commenced* their erosive, or accumulative operations.

Having thus completed the chief object which I had in view, in undertaking this treatise; and having vindicated the truth of Scripture, on this great and disputed point; it would be to plunge most injudiciously into the very same error, in which others have become involved, were I to attempt theorizing upon the *means* by which this vast change was brought about, under the guidance of Creative Power and Wisdom. As well might we attempt to refer to *second causes*, the first creation of our planet, or the separation of its elements into distinct divisions of *fire*, *air*, *earth*, and *water*. "Let the waters be gathered into one place, and let dry land appear!" was, and *must have been*, the command, when the *first sea* was set within its *first bounds*. In tracing, as philosophy is so fond of doing, all things to second causes, we find no attempt to explain the chemical cause or origin, of the *waters* of the ocean. They do exist, however, as a distinct and independent portion of created matter, and, there was a time, therefore, when these waters *came into being*. Their very nature and fluidity imply, that had not a place been appointed for them, below the level of what was to be dry land, these waters must have overspread the entire planet. This, however, was not the intention and *design* of the Creator. The land and water were to be separated; and we are told, what we can well conceive, that "*it was so*," the moment the Almighty issued his command. To no *second cause* can such an operation be attributed; and, accordingly, we find all geological theorists prudently stopping short, before they come to *the origin* of the contending elements of which they treat, and thus leave the *creation* of *fire* and *water*, in the only Hands that could have produced them. Where, then, is the difficulty in conceiving a change of purpose, in the Divine plans; or why should we doubt that the original mandate may have been repeated, in the execution of this new purpose? It was within the scope of Almighty Goodness and Justice to "*destroy the earth*," and to destroy its inhabitants, who had "corrupted their ways" before Him. He does destroy the earth accordingly, and graciously saves a small remnant of mankind, to hand down to all future generations, a record of this awful judgment. This destruction of the earth could be brought about in no way more effectually, (with the prospective view of *benevolence* to mankind, to which its present beautiful and *orderly derangement* bears witness,) than by a renewal of the Divine Command, and a *re-arrangement* of the order in which sea and land were originally placed. We are led, then, by the facts which have now been described, and by analogy from the original " gathering together" of the sea into its hollow bed, to believe, that when the awful sentence of destruction was to be executed *upon the earth* and its inhabitants, the old dry lands became SLOWLY *and gradually engulphed,* either by their *sinking* under the level of the waters, or by the bed of these waters being as slowly *elevated,* into what was to be *a new dry land,* or even by a combination of both movements. In short, though " the windows of heaven" are described as having been " opened," and the contending atmospheric elements to have thus been brought powerfully into action, yet, it is added, that the depths, or " fountains of the great deep *were broken up,*" which announcement is in the most complete accordance with the facts which have now been detailed*.

That this was a *slow* and orderly movement, upon a vast scale, we may clearly infer, from the trifling derangement of the strata of the present earth, over a great extent of country. Had it been otherwise, or had it been effected by the mere medium of volcanic force, we must have seen those strata, and our present lands, for the most part in a state of such disorder as volcanic districts always exhibit; but this would have been highly unfavourable to the future wants and comforts of mankind, as we may clearly perceive, from the general *absence* of such marks of volcanic agency, over vast tracts of the richest country. That the process of destruction, then, was *slow* and *gradual*, we have a right to infer, from physical facts, independent of Scripture testimony, which informs us that the whole time occupied in *the rise*, *the prevalence*, and *the subsidence* of the waters, was upwards of *twelve months*. To this *slow* aqueous process, then, we can trace that easy and flowing outline which forms the general characteristic in existing lands, and to which is due that rich fertility and beauty which these lands so generally exhibit. In the *slow*, yet steady power of the waters, universally receding from off the new dry lands, we cannot fail to perceive the only conceivable *cause* and *origin* of that beautiful system of drainage, which was effected

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* " Sir John Leslie has shown," says Dr. Prout, " that if all the aqueous vapour which can, at any one time, be held in solution, *by the whole atmosphere,* were *at once precipitated* on the earth, it would not be more than about *five inches in depth.*"—*Bridgewater Treatise.* As much more than this quantity falls in rain during the year, the supply must be constantly kept up by evaporation from the waters of the earth's surface. Now, although this is sufficient to account for great discharges of rain,

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by which, and by a combination of all the other terrors of the atmosphere, the horrors of a universal destruction were likely to be accompanied, yet we are precluded from supposing, as some have done, that the Mosaic Deluge was mainly attributable to torrents of rain, from the atmosphere.

by those deep *grooves* which every where overspread the earth, and which invariably point, not in any one direction, as if the result of some mighty and transient diluvial *wave*, but *on all sides*, and *in every country*, to the exact level of the surrounding ocean, in its new bed. These grooves of diluvial drainage, we term *valleys*. When the Divine decree had been fully accomplished, and the *new earth*, and *new sea*, had become fixed at their new relative levels, the atmospheric mechanisms again came into steady operation, in their more usual course; and the rain, the dew, and the snow, once more nourished the earth. The flow of their waters, was drained off, on every hand, into the valleys, *which now covered the surface of the new earth.* They flowed on gently, *in the deepest parts* of those vast winding grooves, which had been so lately filled by the diluvial waters. If a ledge of more solid rock had resisted the powers of these latter currents, the atmospheric streams were precipitated over it, in what we now so much admire, as foaming cataracts. Their ceaseless friction affords us the key to the fact of a *commencement;* and in the remarkable case of Niagara, this the greatest of all cataracts, seems to have been purposely appointed, to confound the reasoning of the sceptic, and to open a more secret cabinet, distinctly disclosing to us the very *date* of this event*.

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* While these pages are preparing for the press, the following notice of a *second Niagara*, has appeared in the public journals.

But such grooves were not all doomed to be the beds of brooks and rivers; by far the greater number were, for ever, to remain *dry;* and such valleys, besides their usefulness and beauty, as greatly increasing the superficies as well as the richness of the dry

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It may possibly prove not less interesting and instructive, with reference to our present subject:

THE NIAGARA OF SOUTH AMERICA.—Extract of a letter, dated Berbice, November 11, 1836, to a gentleman in Inverness: "I have almost forgotten to tell you of an expedition sent out by the Geographical Society, to explore the interior and trace the limits of British Guiana, under a Mr. Schomberg. On this mission he proceeded up the Courantyne River, (this is the river that divides British from Dutch Guiana, or, what may be better understood, Berbice from Surinam; it cannot be less than ten or twelve miles wide where it discharges itself into the Atlantic Ocean,) about six weeks ago, and has just returned, finding it impossible to penetrate beyond the cataracts, which he describes as tremendous—exceeding any he had ever seen, except the Falls of Niagara. From the drawings which he has taken, the scenery must be of the most splendid description; the distance from the coast in a direct line only one hundred and fifty miles; following the course of the river, about three hundred miles. He describes the river as upwards of a mile in width, tumbling in successive cataracts from a height of ninety feet, one of the falls being forty feet in perpendicular height. Several small islands, covered with trees, divide the current of the river into distinct falls, and add much to the beauty of the whole. Mr. Schomberg is now about to proceed up the Berbice river till he gets into a more southern latitude than the above cataracts, when he will strike across, in an easterly direction, to the Courantyne again, and trace that river to its source."—*Inverness Courier.*

land, now step forward and give their unequivocal testimony in corroboration of the *Word* as well as the *Works* of their Divine Creator. They clearly declare *their* SIMULTANEOUS *origin*, and distinctly contradict those philosophic theorists who would attribute all things to merely *second causes*. On the cessation of the diluvial catastrophe, then, all the new dry lands were left, *smoothed off to the very level of the new sea;* and all the main valleys were of course terminated, exactly at that point, beyond which the action to which they owed their origin, *ceased* to have power. But such perfect slopes as the new sea coasts then exhibited, were not doomed to stand for ever. The undulations of the waters, the tides, and the currents, began their friction, on every point which was exposed to their influence. A *small cliff* was the immediate consequence: but when the *cause* was absent, so was the *effect*, and thus we find *both*, in accordance, even at the present hour. Where the sea breaks violently, *there* we find a cliff. Where the force is absent, *the original slope still remains;* and lest any doubt should exist as to the *commencement* of this action, we have the ready means always at hand, of fixing, by the most simple line of testimony, the very period when it must necessarily have begun.

This period has been shown to correspond in a wonderful manner with the chronology of post-diluvian History; and thus far, we find the truth of

Revelation completely vindicated, and the inspired *Word* of God corroborated by his *Works*[*]. If such, then, is at length the case, with regard to so great an event as the *destruction* and *renewal* of the whole habitable earth, we are, in like manner, prepared to find in other points of human reasoning, where it opposes the simple interpretation of the Word of God, some equally deep-rooted error and inconsistency, by which that *obscurity* has been engendered, which almost every one admits as characteristic of the theories of geology.

Before concluding this Chapter, I may take the opportunity of alluding to one or two subordinate points respecting the Deluge, which have been adduced, from time to time, as proofs of its *improbability*. One objection has sometimes been advanced on the subject of the *rainbow*, which, it is asserted, must have existed throughout all time, as a necessary effect of the laws of optics, while the mention made of it in Genesis may seem to imply that it *first* appeared, only after the Flood. This latter idea has probably arisen from the expression "*set*" in our English translation: "I do *set* my bow in the cloud," *as a token* of the covenant. It has been, however, very consistently explained by critics, that this English term "*set*" would have been as *correctly*, and more *comprehensively* rendered, by the word "*appoint*:" thus, "I do *appoint* my bow in the cloud, as a token of the covenant," &c., in the same manner as we say, "set times" for "appointed times," or "a set form of prayer," in speaking of our Liturgy. This expression, as meaning "*to establish, to appoint, to fix*[*]" is still in use, though much less commonly now, than at the period when the translation of the Bible was made. "We are informed in the Sacred Narrative," says Dr. Prout, in describing the rainbow, "that this beautiful phenomenon, was *chosen* as a symbol to mankind of their exemption from future Deluges. The sceptic may be challenged to state, what pledge could be so felicitous, or more satisfactory. In order that the rainbow may appear, the clouds must be *partial*. Hence the existence of the rainbow is absolutely incompatible with *universal* deluge from above. So long, therefore, as 'He doth set his bow in the cloud,' so long have we full assurance that these clouds must continue to shower down *good*, and not *evil*, upon the earth[†]."

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[*] "The *works* of God, and the *Word* of God, may be called the two doors which open into the temple of Truth; and as both proceed from the same Almighty and Omniscient Author, they cannot, if rightly interpreted, contradict each other, but must mutually illustrate and confirm, though each in a different sort and manner, the same truths."—*Kirby's Bridgewater Treatise*, p. 1, *Introduction*.

A second and more direct objection has been raised, upon the "olive leaf" spoken of in the 11th verse of the eighth Chapter of Genesis. "The olive branch which was brought back by the dove," says an able writer, "seems as clear an indication *to us*, that the vegetation *was not destroyed*, as it then was to Noah, that the dry land was about to appear." "For our own part," continues he, "we have always considered the flood, if *required* to admit its *universality* in the strictest sense of the term, as a preternatural event, far beyond the reach of philosophic inquiry. At the same time, it is evident, that they who are desirous of pointing out the coincidence of geological phenomena, with the occurrence of such a general catastrophe, must neglect no one of the circumstances enumerated in the Mosaic History; *least of all* so remarkable a fact as that the olive *remained standing*, while the waters were abating*." There are probably few readers who have attentively considered the Mosaic narrative of the flood, and the unavoidably destructive consequences to vegetation, of such an event as the destruction *of the earth*, as well as its living furniture, who have ever imagined that the olive leaf brought back by the dove, was plucked from an *ante-diluvian* olive tree. We have no reason, from the narrative itself, for such a supposition; while the repeated declaration of God, that he would destroy *the earth*, or dry land, puts the impossibility of the thing beyond a question†.

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[*] See *Johnson's Dictionary*.

[†] *Prout's Bridgewater Treatise*, p. 345.

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* *Principles of Geology*, Vol. III., p. 273.

† When we now speak of "*the Earth*," we generally mean our entire planet, and as such, some may perhaps misapprehend the term as used in the above expression. But in the 10th verse of the first chapter of Genesis, we read, that after the separation

Too often, and too long, has this declaration been entirely overlooked. "Whence then," may the above author ask, "came the olive leaf?" Whence, we may ask, in return, came the vegetation on which the first created animals fed? and how was the face of the earth "*renewed,*" and re-arranged in the beautiful order in which we now see it? We can no longer refer the Flood, to the *partial action of mere second causes,* until the facts which have now been detailed have been disproved, and the plain inferences from them consistently refuted; and although no mention is made, by the Sacred Historian, of the exercise of *Creative* Power, after the Deluge, yet we are left to infer the unavoidable *necessity* of such re-arrangement, unless we are prepared to reject both the Record of the Flood itself, and the clear corroborations of that Record, which can now be drawn from the geological phenomena of the earth.

That there was, in reality, a complete re-arrangement of the face of the earth after the Deluge, and by that Power which could alone have created and destroyed it, can be shown from numerous facts in nature, and in none more than in the remarkable

of the land and waters, "God called the dry land *earth*, while the gathering together of the waters, called he *seas*." In the subsequent use then, of the term "*earth*," as referring to God's intention to "*destroy*" it, and finally, of its having actually been "*destroyed*," we are, of course, to understand, that the "*dry land*," which he had called *earth*, was thus condemned to destruction, together with its inhabitants.

allotments into classes, of *plants*, and of *fishes*. This may be illustrated by reference to our own island, as a model. We have shewn to demonstration, that this island was freed *from a general watery covering*, but a very few thousands of years ago. No one will probably question, that that covering was *the sea* which now frets upon its coasts; whence, then, may we ask, came the arrangement of *fresh-water fish*, in our inland streams, and especially in those now cut off from the sea, by insurmountable cataracts? If they were left by the waters of "*the last cataclysm*," why are not cod and turbot also found naturalised in our inland lakes and streams? Why, in short, should the fresh-water fish of all rivers, be distinct in species, *and yet different, in different streams?*

Then, again, with regard to plants. How can we account, except by a reference to Creative Power and Wisdom, for the present wonderful order of all things as regards *climate?* We learn from the botanist, that in general, the plants of America differ from those of the Old World; and that those of New Holland also differ, with a few exceptions, from the plants of all the rest of the world. In the small island of St. Helena, out of sixty native species, only *two* or *three* are said to belong to any other part of the globe! "Such facts," says Dr. Prout, "are quite inexplicable, upon any known principles; and are calculated to excite a more than ordinary degree of attention, as being solely referrable to the *Will* of the Great Creator, who has chosen to provide infinite *diversity*, where all might have been *uniform* and *monotonous;* and has thus rendered more conspicuous, his Wisdom, his Power, and his Goodness*." The same author draws an admirable picture of the distribution of plants, as they vary with the climates, from the equator to the poles; and also of similar changes which take place *vertically*, from the base to the summits of the tropical mountains, capped as these often are with such eternal ice and snow as prevail around the poles. The *isolated* instance of this wonderful arrangement, presented by the Peak of Teneriffe, is of itself sufficient, as a conclusive proof of the subject now in question.

The whole of the sixth Chapter of Dr. Prout's treatise, when connected with the *very recent birth* of our dry lands, above the waters, which has now been proved, will convince every candid mind, of that Creative Agency, by which the *renewal* of the face of nature must have been effected, after the Deluge†. When all these beautiful arrangements are clearly explained, as having arisen from the *mere laws of nature,* we may then return to the question of *the origin of Noah's olive leaf.* Until then, the objection founded upon it, must be regarded as altogether trivial, however able may be the work from which that objection is drawn*.

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* *Prout's Bridgewater Treatise*, p. 369.

† "Thou hidest thy face, they are troubled; thou takest away their breath, *they die*, and return to their dust. Thou sendest forth thy spirit, *they are created; and thou* RENEWEST *the face of the earth.*"—*Psalm* civ., 29, 30.

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* There is one instance of Creative design, mentioned by Dr. Prout, which I may be excused for quoting in this place, though perhaps less directly applicable to the subject above discussed. In speaking of the *hibernating* of plants, and the *intermittent growths* of vegetables, in the temperate and the colder climates, differing in this respect from the perpetual verdure exhibited in the tropics, he exclaims: " And here we have displayed another of those admirable provisions, which at once strike us irresistibly, as being the effect of Design. In tropical countries, where the seasons are uniform, and where there is no cold to injure, the leaf buds of plants are without covering or protection, and are freely and confidently exposed to the atmosphere. But in climates where the seasons change, and where vegetation is liable to be suspended by the cold, the leaf buds exhibit a structure remarkably different. Developed in the latter end of summer or in autumn, they are almost invariably provided with *tegmenta*, or *coverings*, within which, during their period of torpor, *they are cradled safe from cold or accident!*" — (*Bridgewater Treatise*, p. 374.) Precisely similar is that wise provision, by which animals are also *covered* with, or *relieved* from, a warm clothing, according to the season, and to the particular climate, to which they may be imported. " Every one," continues the same author, " is acquainted with the general fact, that wool, fur, eider-down, and similar articles, are obtained for the most part, not from these copious sources of every superfluous production, *the countries within the tropics*, but from the cold, and comparatively unprolific regions, of the temperate and frozen zones, where they have constituted the appropriate vesture of different animals. Perhaps, in the whole range of creation, there is not any thing more calculated to excite our admiration."—(p. 400.) Such things occurring among *plants*, and especially a distinct and appropriate arrangement of species, in ascending order, *on an isolated mountain*, bear the most conclusive testimony to *creative* interference, *subsequent* to such localities being freed from the waters.

CHAPTER X.

PROOFS OF THE INCONSISTENT AND ERRONEOUS NATURE OF THE LATEST GEOLOGICAL THEORIES RESPECTING THE PROBABLE AGE OF THE EARTH. EVIDENCES OF THE MOSAIC DELUGE HAVING BEEN THE ONLY EVENT OF THE KIND, TO WHICH THE GLOBE HAS EVER BEEN SUBJECTED. CONCLUSION.

HAVING shown, by the varied evidences from nature, described in the foregoing Chapters, that the Flood, so explicitly described in Scripture, not only was a real event, to which the general face of nature bears universal testimony, and in the operation of which, a vast, and altogether *preternatural* change was effected between sea and land; but also that it was a *universal*, and not a mere *local* catastrophe, to which many of those geologists, who acknowledge it at all, seem disposed to reduce it; and having been enabled by new and most unlooked-for natural evidences, to demonstrate, so nearly, the real period of this event, as that no reasonable doubt can now be entertained of its exact accordance with the date given to it in Sacred History; it becomes a part of the duty which the observation of these new evidences has imposed upon me, to proceed still further in our inquiry; and to examine whether this event is the only one of the kind, to which the phenomena of geology bear testimony; or whether, on the contrary, the opinion of those philosophers is well founded, who imagine that the regular order of nature has been *frequently* interrupted by such Deluges; or rather, that they constitute, like the earthquakes to which they attribute them, a mere part or consequence of those laws, by which, as they suppose, nature has been uninterruptedly governed*.

In the prosecution of this part of our inquiry, it is not my intention to refer to Scripture, as bearing distinct negative testimony, against the idea of *repeated* Deluges. My design is rather to follow the course already pursued in the foregoing Chapters, and to draw my inferences from *natural phenomena*, as far as their evidences are exposed to our view. But though this may be the most proper, and the most philosophic mode of dealing with the subject, I would by no means have it inferred that I undervalue, or set aside, the conclusive testimony of Revelation, on this point. On the contrary, I should myself be content to rest, with the fullest confidence, on the unerring truth of revealed testimony, on this as on all other points, especially if they are beyond my own ready comprehension: but as this may not be the feeling of numbers who take an interest in geology, and who conceive that its facts ought to corroborate and explain the more obscure notices of physical events relating to the earth, which are incidentally afforded by Scripture, in recording God's dealings with man, it may be more satisfactory to such persons to exclude, for the moment, what the Scriptures have taught us, with regard to this particular subject, with the distinct reservation, however, that they are in no wise freed from their allegiance to the Word of God, by any imperfection which they may conceive to exist, in the evidences which I may now adduce, in support of that Word. For though it may, in this case, be advisable, to meet the objections of philosophy, by adducing *physical facts*, instead of *Scripture testimony,* we cannot forget that the Deluge is there described, in terms that leave no room to regard it as one of the common occurrences of nature, and consequently, as *the last of many such events.* If this negative testimony be insufficient, we have the fact of its having been a PRETER-*natural* event, clearly and affirmatively indicated, in that passage wherein God makes a solemn covenant with his creature, man; and declares that He " will not *again* smite any more, every living thing, as He had done;" that all flesh " shall not *any more,* be cut off by the waters of a flood;" and that "while the earth remaineth, seed time and harvest, and cold and heat, and summer and winter, and day and night, shall not cease;" *as* (it is, of course, implied,) *they had done,* during the prevalence, for more than twelve months, of this awful and destructive judgment. Nor ought we here to omit the very striking fact, that the sole *object* of the Flood, had a distinct reference to the *moral guilt* of the human race, in which guilt the brute tribes could in no way participate, although it was the will of God that they also should perish, in the general destruction of the earth. It seems, therefore, the height of inconsistency for the geologist who has any belief in Scripture at all, to suppose that the Almighty should have repeatedly brought *such Floods* upon the earth, at periods when he must know that no moral guilt could possibly have been incurred, that is, during the " *myriads of ages before the creation*

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* "Amid all the revolutions of the globe, the economy of nature has been uniform, and her laws are the only things that have resisted the general movement. The rivers and the rocks, the seas and the continents, have been changed in all their parts; *but the laws which direct these changes, and the rules to which they are subject, have remained invariably the same.*"—*Playfair*, and adopted as the motto of Mr. Lyell's *Principles of Geology*.

"These general dispositions of all strata, in the form of troughs or basins, have resulted from two distinct systems of operations, *in the economy of the terraqueous globe;* the first producing sedimentary deposits, (derived from the materials of older rocks, and from chemical precipitates,) on those lower spaces into which the detritus of ancient elevated regions was transported by the force of waters; *the second raising these strata* from the sub-aqueous regions in which they were deposited, *by forces analogous to those whose effect we occasionally witness*, in the tremendous movements of land, *that form one of the phenomena of modern earthquakes.*"—(*Bridgewater Treatise on Geology*, Vol. I., p. 528.)

of mankind," which form so prominent a feature in the most popular theories of the science. We are, in this case, then, completely debarred from all power of regarding the Flood as one of many *local* and *natural* events, to which we know that earthquakes sometimes give rise, in certain limited districts of the earth. So far from the earth not being "*again*" smitten, we know that such natural convulsions as these, not only have repeatedly occurred since the above solemn covenant, but must be expected to occur throughout all time, in the same manner as other volcanic and meteoric casualties, which have so *beneficial* an effect upon the atmosphere which we breathe, however terrible and destructive to those individuals who may suffer by them. Such geologists, then, as persist in closing their eyes and minds upon the above solemn declaration of the Almighty, and who deny to that Deluge, a character in any degree different from such local events as have often subsequently happened, and which must, again and again, be expected to occur, practically deny the authenticity, or truth of the revealed covenant; and remain fixed in the determination to judge of all such subjects, only upon such evidences from existing nature, as come within the scope of their own reason and understanding*.

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* "Already, therefore, may we regard the doctrine of the *sudden* elevation of whole continents, by paroxysmal eruptions, as invalidated; and there was the greatest inconsistency in the adoption of such a tenet by the Huttonians, who were anxious to

With the above distinct reservation, then, on my own part, of an uncompromising reference to Scripture, altogether independent of man's imperfect judgment as to *facts*, I shall proceed to state the evidences from facts, by which my own judgment of Scripture testimony has been so powerfully corroborated; in the hope that a like benefit may accrue to others, whose confidence in the Inspired testimony, may have been, more or less shaken, by the inferences of some scientific men; and that these facts may establish and confirm a trust in God's word, which no opposing judgment of erring *man* ought ever to have caused to waver.

And first, we have seen that science has opposed itself to the literal idea of the Mosaic Flood, on the ground that the literal interpretation of the record

reconcile former changes to the present economy of the world. It is contrary to analogy," (with existing nature, we are to presume,) "to suppose that NATURE had been, at any former epoch, *parsimonious of time*, and *prodigal of violence;* to imagine that the disturbing forces were not *kept under subjection, so as never to carry simultaneous havoc and desolation over the whole earth, or even over one great region*."—(*Principles of Geology*, Vol. I., p. 100.) We cannot here fail to call to mind, that part of St. Paul's epistle to his Hebrew converts, in which, while he so beautifully explains the true nature of *faith*, he distinctly alludes to the *preternatural* nature of the Deluge. "By *faith*, Noe, being warned of God *of things* NOT SEEN AS YET, prepared an ark to the saving of his house;" &c. The expression "*not seen as yet*," is conclusive, on this subject. The whole chapter (*Heb.* xi.) offers a severe test to such as hesitate as to the nature of many of the events of Sacred History.

led to the necessity of regarding that event as *preter-natural,* and therefore "contrary to all analogy" with existing nature, which has never, in modern times, been known "to carry simultaneous havoc and desolation over the whole earth, or even over any one great region of it." But if there be any value whatever in the line of natural testimony which has now been adduced, especially with regard to such an example as the Isle of Wight, which, as has been proved to demonstration, was raised from the bed of the sea, into its new character of a dry land, *at once,* and but a very few thousands of years ago, the *preter-natural* character of the Deluge must be looked upon as beyond all question, until the paroxysmal elevation of such *unvolcanic* districts as the south of England, of the height of upwards of one thousand feet, can be shown to be possible, according to the common laws *of earthquakes.*

In the second place, geology teaches that, during an indefinite lapse of ages, the strata of the earth's surface were deposited, "*by the very same laws which now regulate the phenomena of nature;*" we are consequently taught to infer, that what has already occurred, may be expected to occur repeatedly again; and that such processes are now in constant progress in the bed of the sea, and of lakes, as have formerly occasioned the phenomena of the secondary strata. That the reader may be fully satisfied of the existence of this theory, I beg to quote the following short passages from the last published

Bridgewater Treatise; as they comprise, in a concise form, the geological theory of its able author, with regard to the general system and march of nature. "As far as our planet is concerned, the first act of creation seems to have consisted in giving origin to the elements of the material world. These inorganic elements appear to have received no subsequent addition to their number, *and to have undergone no alteration in their nature and qualities;* but to have been submitted, at their creation, *to the self same laws that regulate their actual condition, and to have continued subject to these laws during every succeeding period of geological change.*"—(Vol. I., p. 35.) We are not to infer from this passage, however, that the "*elements*" of our planet, here spoken of, were the *four* distinct divisions of *fire, air, earth,* and *water;* for we afterwards find that *water* was not originally created *as such,* but was in a state of *vapour,* in which state it continued for a period sufficiently long, to admit of *the red-hot earth* cooling down to that point at which this vapour *could be condensed;* and thus, water was not a consequence of direct *creation,* but arose subsequently, by a *second cause,* or a law of nature. Of this we are informed, in subsequent parts of the above work. In the concluding Chapter, its author says: "In the early part of our inquiry, we traced back the history of the primary rocks which composed the first solid materials of the globe, to a probable condition of *universal fusion,* incompatible with the existence of any forms of organic life; and saw reason to conclude, that as the *crust* of the globe *became gradually reduced in temperature*, the unstratified crystalline rocks, and the stratified rocks produced by their destruction, were disposed, and modified, during long periods of time, *by physical forces, the same in kind with those which actually subsist*, but more intense in their degree of operation; and that the result" (*of these physical forces*) "has been, to adapt our planet to become the receptacle of divers races of vegetable and animal beings, and finally to render it a fit and convenient habitation for mankind*." From this theory, so highly favourable to *second causes*, and apparently so derogatory to a Creative First Cause, we perceive that *water* could not have been created *as such*. When it was at length added, that is, before the earliest stratified sediments were arranged, (for strata necessarily imply the presence and movements of water), it must have been *much too hot for the existence of fishes*; accordingly, we are told that no fishes are to be found in the earliest strata of gneiss, &c. "The total absence of organic remains, throughout the lowest portions of these strata which have been called primary, is a fact consistent with the *hypothesis* which forms part of the *theory* of *gradual refrigeration; viz.* that the waters of the first oceans, *were too much heated*, to have been habitable by any kind of organic beings. So long as the temperature of the earth continued intensely high, water could have existed *only in the state of steam*, or vapour, floating in the atmosphere, around *the incandescent surface**"*!* "Long periods of time," pass on, however; and the *smoking* earth and seas became, at length, cool enough for the reception of some few species of moluscous creatures. Their remains are accordingly found embedded in some of the transition rocks, although it is extremely difficult to conceive how the fine materials composing these rocks were produced. For such rocks imply *sediments;* sediments imply *rivers;* rivers imply *rain*, *dew*, &c. while these latter meteors imply a *cold* earth, or dry land, on which the atmospheric vapours must have been condensed; and this condensation could not readily be effected, when the smooth surface of the granitic sphere must yet have retained so high a degree of temperature. I speak of the *smooth* surface of the cooling sphere, because we cannot easily conceive the existence of mountain ridges, at so early a stage of the earth's *growth*, when it had so recently cooled from a fluid state, and before earthquakes had begun, by *small* and *oft-repeated* shocks, to roughen the earth's surface. We thus entirely lose sight of water as a *created* substance; and it is difficult to conceive it even in this gaseous state, at the period when the whole globe was in its first condition of *intense fusion.*

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* *Bridgewater Treatise on Geology*, Vol. I., p. 581.

* *Buckland's Bridgewater Treatise*, Vol. I., p. 53.

How much more worthy of a Creative First Cause, is the manner in which this part of the original history of the earth has been dwelt upon, in the works of some other able writers! In treating of the *nebulous* theory, or of our *solid* earth having once been a mere heated *vapour*, like a comet, one author makes the following reflections: "Why," asks he, "must the primeval condition be one of change at all? Why should not the nebulous matter be equably diffused throughout space, and continue for ever in its state of equable diffusion, as it must do, from the absence of all cause to determine the time and manner of its separation? Why should this nebulous matter *grow cooler and cooler?* why should it not retain for ever the same degree of heat, *whatever heat be?* If heat be a fluid, if *to cool* be to part with this fluid, as many philosophers suppose, what becomes of the fluid heat of the nebulous matter, as that matter *cools down?* Into what unoccupied region does it find its way? Innumerable questions of the same kind might be asked, and the conclusion to be drawn is, that every new physical theory which we include in our view of the universe, involves us in new difficulties and perplexities, if we try to erect it *into an ultimate and final account* of the world in which we live."—"If such theories claim a place in our natural theology, as well as our natural philosophy, we conceive that their pretensions will not bear a moment's examination*." The same reasoning will apply to the theory of an original *fused mass* of matter, and to a *nebulous vapour*, if, as in the case we are now considering, it is the highest condition to which theory traces our globe.

On the subject of *water*, as a created portion of the earth's system, we are told by another able writer, that, "*within very narrow limits of temperature*, it is a *solid*, a *liquid*, or a *gas*; and yet," adds he, "these very narrow limits of temperature, *neither more nor less*, are precisely those which exist upon the surface of the globe, where *they are the natural and necessary result of its situation in the universe*, and of those general laws which govern the distribution of light and heat. Had the properties of water been other than what they are, or had the general temperature been different, it would have existed altogether either in the solid, or in the gaseous state, and its most important properties would thus have been unknown. It seems therefore impossible to arrive at any other conclusion, than that the temperature of the earth, and the properties of the waters upon its surface, *have been mutually adjusted to each other*†." If, on the other hand, we are to adopt the theory of *the gradual refrigeration of the earth*, from an original state of fusion, we must suppose water to be now, only

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* *Whewell's Bridgewater Treatise*, p. 190.

† *Prout's Bridgewater Treatise*, p. 159.

casually in one of its stages, from its origin as a *vapour*, to its ultimate state as a *solid;* for if the earth has gradually cooled down hitherto, we know of no law in nature by which that cooling process can be checked, or entirely brought to an end. Thus the idea of *Creative Design* is altogether set aside, and second causes, or the laws of *cooling*, adopted in its stead!

Before quitting the subject of the origin of water, as one of the most wonderful and important parts of created matter, I cannot but think that the following passage from one of our soundest philosophic works will prove acceptable to the reader. "The constituents of *climate*, even imperfectly as they can be understood by us, are seen to be adjusted and arranged in a manner so surprising, that, to those who admit the existence of *design*, they require only to be stated and apprehended, in order to their being received as additional proofs of that great argument. Where all are great, and splendid, and good, selection is precluded; but the circumstances accompanying the distribution of *water* over this globe, more than perhaps any other, arrests our notice as indicative of *design*. Leaving out of view the other properties of water, on what other supposition, besides that of design, can we account for all those astonishing properties, on which depend its evaporation, and diffusion through the atmosphere—its subsequent condensation, not at once, in the form of water or ice, but in the intermediate state of *clouds*—its colour and lightness when in the state of snow—its power of refracting light, and of conducting electricity — in short, all the numerous, minute, and happily contrived qualities displayed by this highly elaborate fluid? These together, form such a union of adaptations and arrangements, each most successfully accomplishing a particular purpose, and apparently directed to, and designed for, that purpose, that to doubt the agency of *design* would seem impossible. Yet there are some men's minds so warped, that they either cannot, or will not be persuaded of the existence of design: but asserting the omnipotence of *the laws of nature*, they forget Him who framed these laws, and are reluctant to give credence to His being or to His power. To such persons, meteorology offers one or two exclusive arguments, which we shall briefly urge in this place." The author then proceeds, in his able manner, to explain a few of the most remarkable general laws with respect to fluids, and shows the very striking *exceptions* to these laws, which prove *intention* for a particular purpose: thus it is a general law, that " all bodies are *expanded* by heat, and are *contracted* by cold. If water had not constituted an *exception* to this law, though all its other properties had been the same as they now are, long before this time, half the water on the globe would have been converted into *ice;* and the existence of organised beings would have been physically impossible." Again, it is another general law, that "all chemical substances combine in certain proportions, *and in no others.* But if the *air* had been formed according to this law, every thing else being the same as at present, long before this time, half the air in the atmosphere would have been contaminated, and rendered unfit for the support of animal life. In order, therefore, that *water might not be frozen,* and that *air might not become irrespirable, laws must be infringed*—and THEY ARE INFRINGED; infringed, too, precisely where their infringement, both in kind and degree, is indispensably necessary to organic existence."—"We cannot resist the conviction," adds he, "that one purpose of this arrangement has been that of confounding the presumptuous sceptic, who is thus perpetually reminded of the *infringement* of his boasted 'laws of nature,' by the very *water* he drinks, and by the very *air* he breathes*."

But to return to the theory we were considering; from the *commencement* of our earth, in a state of fusion, and unfitted for the reception of organic beings, we are led through "*millions of millions of years,*" during which the secondary strata of the earth were deposited, under the influence of "*the same laws which actually subsist.*" "However constant," says another talented writer, who entertains a theory somewhat similar, "we believe the relative proportion of sea and land to continue, we know that there is, annually, some small variation in their respective geographical positions; and that in every century, the land is in some parts raised, and in others depressed, *by earthquakes*, and so likewise is the bed of the sea. By these and other ceaseless changes, the configuration of the earth's surface ***has been remodelled again and again***, since it was the habitation of organic beings, ***and the bed of the ocean has been lifted up***" (that is by earthquakes), " to the height of some of the loftiest mountains. The imagination is apt to take alarm, when called upon to admit the formation of such irregularities of the crust of the earth, after it had become the habitation of living creatures; ***but if time be allowed, the operation need not subvert the ordinary repose of nature;*** and the result is insignificant, if we consider how slightly the highest mountain chains cause our globe to differ from a perfect sphere*." I have been led to insert the above quotations, to show the latest opinions, and the most influential authorities in the geological world; and more especially as these opinions are directly opposed to the whole line of facts which it has been the object of this volume to describe. It is for the candid and judicious reader to judge between the above described *facts*, directly corroborated by the distinct testimony of Revelation, and these *theories*, unsupported as they are, nay directly opposed, by that inestimable written authority.

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* *Prout's Bridgewater Treatise,* p. 356.

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* *Principles of Geology*, Vol. I., p. 130.

We thus learn, not only that all stratification has taken place *in water*, by the movements of which alone, it is naturally produced; but that there is a general impression amongst geologists, that the same laws which produced, in antediluvian times, the regular series of rocky strata, are now slowly working precisely similar effects, in the bed of our seas, or of our inland lakes of fresh water. It has frequently been said, with regard to geological controversies, that it is much easier to *destroy* a theory, than to *construct* one; and I fully admit the truth of the observation. But a theory founded on truth, cannot be so destroyed; and we are better without any theory, than with one which is evidently founded in error, and propped up by inconsistencies. Having neither the wish nor the intention to attempt the construction of theories, or to account, as others have ineffectually attempted to do, by the *laws of nature*, for all the wonders of the mineral strata, my present object is, to point out a few of the "glaring instances" which these strata present, in proof of a former different state of things, from that now existing; and as we can conceive, and judge of natural facts, by *comparison* alone, we must admit our utter inability to theorize soundly, on such facts, if this, our only medium of conception, be withheld from us. We cannot, for example, form the faintest idea of the mode of exercising *creative* power, because we never have seen that power exercised. The mind, therefore, tacitly believes the fact of creation, without any attempt at divining the *mode* by which it was brought about. So also, in the fact of such a great and general interchange taking place, between sea and land, as has just been demonstrated, we are forced by our *facts* to admit the reality of such a change; and though minute occasional examples of local convulsions, in volcanic districts, may assist our reason in some small degree, yet the mind is soon overwhelmed with the complete disproportion both of *cause* and *effect*, in the two cases, and instantly submits in silence, to acknowledge a power far surpassing its widest experiences. In like manner, with regard to the phenomena of the regular series of strata, which exhibit so much of Wisdom, Power, and DESIGN, for the ultimate benefit of the human race; although our conceptions of the mode of their formation, are assisted by such laws of deposition in fluids, as are now in action, yet a little consideration and comparison between the ancient and recent *effects*, will soon tend to convince us, as in the case of the Deluge, that the power of comparison altogether fail us, beyond a certain point; and that the *mode* of such unusually extensive processes, is far beyond the limits of our utmost *experience*. As the first step, therefore, to a sound judgment of things, is to eradicate from our minds any *unsound* inferences which may have influenced them, I shall now endeavour to show that we must be infallibly led into error by judging, as geologists now generally do, of *past* events, by analogy and comparison with the *present* settled march of nature; and that by this erroneous line of reasoning, we sap the foundations of all our confidence in Revelation, without constructing any consistent geological theory, that can be, in the least degree satisfactory, to a candid and reflective mind.

I must now refer the reader to a former part of this treatise, where a general view is given of the whole series of stratified rocks, from the diluvium which forms the universal covering of the earth, down to granite, to which, as the lowest known rock, all mineral matter has been traced. As most of these rocks are *stratified,* and thus show proofs of their having once been in a soft state, and subjected, as *sediments,* to the laws of fluids, geologists conceive, that they have, therefore, arisen from the very same species of meteoric and aqueous action as is now constantly removing mineral matter from the land, and depositing it in the bed of the waters, in the form of mud and sand. As this action is now so slow, as to have effected but little visible change within the historic period of some thousands of years, it is therefore inferred that, *in the same proportion, and on the same scale of measurement,* both as to cubic deposition, and the time required for it, the age of these secondary strata must be almost incalculable; and therefore, that the "*popular* and commonly received interpretation of the Mosaic Narrative," respecting the Creation and the subsequent age of the earth, "requires some *modi-*

fication," or, in other words, must be set aside*. Thus, the whole argument as to long periods of time, is based upon the hypothesis that the laws of nature, with respect to deposition, have always been the same as they now are; and the stupendous theoretic fabric thus built upon it, must stand or fall, according to the solidity or weakness of this hypothesis.

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* We find the following singular passage in a late important work:—"If the suggestion I shall venture to propose, require *some modification* of the most commonly received, and *popular* interpretation of the Mosaic narrative, this admission neither involves any impeachment of the authenticity of the text, nor of the judgment of those who have *formerly* interpreted it otherwise, *in the absence of information as to facts* which have but recently been brought to light; and if, in this respect, geology should seem to require *some concession* from the literal interpreter of Scripture, it may fairly be held to afford *ample compensation* for this demand, by the large additions it has made to the evidences of *natural* religion, in a department *where Revelation was not designated to give information*."—*Bridgewater Treatise on Geology*, Vol. I., p. 14.

On this claim to concession, it has been well observed by a very able writer, in a pamphlet just published, "we occasionally hear from geologists an intimation, that some concession might be expected from the *literal* interpreter of Scripture, to meet *the compensation* which geology offers, in the shape of additional testimony to religious truth. Such intimations are inconsiderate. To the benefit of any *justifiable* interpretation of the Mosaic Record, though different from that which has hitherto been received, geologists are entitled, *without payment for it*. Of the original interpretation, if believed to be the truth, *not an atom can be relinquished, on the principle of barter*."—See p. 23 of "*Considerations on Modern Theory of Geology*," by the Reverend Thomas Gisborne, Prebendary of Durham.

I have now before me some fossils and hand-specimens, which were lately sent from New South Wales. The first glance at these specimens is sufficient for an experienced geologist to be assured that they belong to the formation termed *mountain limestone,* which lies low in the carboniferous group of strata; and he thus becomes certain that the mountain limestone is found in New South Wales. Beside these, lie other specimens, both of rocks and of fossils, *which are precisely similar,* and which I have myself collected from three European localities, in Wales, in Ireland, and in Germany, and all from the formation well-known as the mountain limestone. The question instantly occurs, then, can any formation *like this,* be going on at the present day? Are the sedimentary deposits, and the organized beings embedded in them, of the same exact character *now,* in Wales, in Ireland, in Germany and in New Holland? If they are not so, then we cannot imagine ourselves to be *now* living in the epoch of any such *general formation,* as the above specimens bespeak.

But let us prosecute this inquiry a little further. "When we discover *a constant* and *regular assemblage* of organic remains," says the Bridgewater Treatise, "*commencing in one series of strata, and ending with another, which contains a different assemblage,* we have herein the surest grounds whereon to establish those divisions which are called geological *formations;* and we find many such divisions succeeding one another, when we investigate the mineral deposits, on the surface of the earth*." "Thus we find the fossil species of one sedimentary formation, *suddenly ceasing*, at the commencement of another." "The fishes of the oolitic series *ceased suddenly* at the commencement of the cretaceous formations†." "Neither the same genera, nor even the same families of fishes, pervade successive series of great formations; but their changes take place *abruptly, at certain definite points* in the vertical succession of strata, like the *sudden* changes that occur in fossil reptiles and mammalia. Not a single species of fossil fishes has yet been found, *that is common to any two great geological formations*‡." "Ammonites, beginning with the transition strata, appear in all formations, *until the termination of the chalk;* whilst the hamites and scaphites are very rare, and the turrilites and baculites *do not appear at all*, until the commencement of the cretaceous formations‖." Now, it will probably at once occur to the reader, without its being pointed out, that not only can there be *no particular and* GENERAL *mineral formation in progress, at the present time*, analogous to those described in the above extracts; but, if there were, no one could expect that its fossil contents should be *the same in every quarter of the globe.* The shells even on different parts of our own coasts, vary materially; how much more then, those of the Indian, the Pacific, and the Arctic oceans; and yet we are told, at one moment, to judge of the deposition of the geological strata, *by the very same laws which now govern the earth;* and at the next, *that there is a remarkable difference between the two!* "The geographical distribution of ammonites in the ancient world, seems to have partaken of that *universality which we find so common* in the animals and vegetables of a former condition of our globe, *and which differs so remarkably, from the varied distribution that prevails among existing forms of organic life.* We find the same genera, and, in a few cases the same species of ammonites, in strata *apparently of the same age,* not only *throughout Europe,* but also *in distant regions of Asia, and of North and South America.* Dr. Gerard has discovered, at the elevation of sixteen thousand feet, in the Himmalaya mountains, species of ammonites *identical* with those of the lias, at Whitby, and Lyme Regis. He also found in the same parts of the Himmalaya, several species of belemnites, of terebratulæ, and of other bivalves, that occur in the English oolite; *thereby establishing the existence of the lias and oolite formations,* in that elevated and distant region of the world. Mr. Sowerby possesses fossil shells from *Brazil,* resembling those of the inferior oolite of England."—*Bridgewater Treatise,* p. 335. I might multiply, *ad infinitum,* such examples of *universality* in the former sedimentary deposits, and of *unifor-*

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* *Buckland's Bridgewater Treatise*, Vol. I., p. 113.

† *Ibid.* 271.

‡ *Ibid.* 272.

‖ *Ibid.* 370.

mity in their animal contents, which are detailed in the above work; but these few examples may be sufficient for our present argument. The only question that remains, then, is to consider whether the laws now in action on the earth, are producing *similar effects*, for the study of some future geologist. And first, as to the *mineral* composition of particular rocks. Let us take the *red* sand stone, the *blue* lias, or the *white* chalk, as well marked examples. All of them are recognised extensively, in distant corners of the earth; and in all, they are known by the *similarity* of their fossils, and by their every where holding *the same relative positions*, with regard to other strata above and below them. Let us, then, compare with such a result of former sedimentary deposition, what we know must now be going on in the present bed of the ocean. The existing lands consist of all the strata already described. The rivers, by means of which, much of the detritus of these lands is carried into the sea, flow over *the whole of them;* and, consequently, the sediments now lodged in the waters, must be a mixture from the destruction of all sorts of rocks. In like manner, the sea coasts are composed of every variety of mineral formation; consequently the destruction by the waves, there so constant, must occasion deposits of moved matter, of a like mixed character, partaking of the composition of the *whole*, and not confined to that of any one species of rock. One river is perhaps charged more especially with the detritus of *argillaceous* formations; another with *arenaceous* sediments, &c., each according to the prevalence of the rocks, over which it flows. If we view this process on the great scale, we cannot fail to perceive, that though the movements of the waters may sift and arrange the whole into distinct strata, such strata cannot have the universality of *character*, which the older formations exhibit. Far less can their fossil contents, consisting of fish, shells, or vegetables, be the same *in all latitudes*, as appears formerly to have been the case. The analogy, then, on which geologists reason, between the *mode* of former depositions, and the result of existing action, can, in no point, hold good, except that water still possesses, as it always has done, the power of arranging its sediments in *strata*.

These strata which compose the surface of the earth, may, in fact, be likened to a book containing a certain limited number of pages, each page being formed of a different texture and colour, and impressed with different sorts of characters. In the different copies of this book, (the various geological sections,) some are more perfect, in the number of their pages than others, while we find numerous instances of pages being entirely wanting. But notwithstanding such frequent blanks, the general order of the pages is never found *inverted*. Page 20 is never seen before page 12. Blue lias is never seen above chalk; nor is coal ever found above oolite. The tertiary strata, are in like manner placed above the chalk, in all parts of the world. These are *facts* which seem now to be fully established, by the extended researches of geologists. But in addition to this *universality* of arrangement in the different formations, there is another fact of a still more striking character, which seems never to have occurred as a difficulty in the invention of geological theories, but which implies a former state of things as obscure to us, as far as regards its *cause*, as *the mode of operation*, both in the case of the Creation, and of the Deluge. The different leading members of the geological series of rocks *never occur but once in that series.* Thus we have but *one* group of carboniferous rocks; but *one* formation of magnesian limestone; but *one* instance of blue lias; but *one* formation of chalk, &c.; nor is this difference confined merely to the fossil contents of a group of strata; for although all these formations may have been formed simply of sand or of clay, variously affected by chemical changes, yet a distinct *colour* and *character* is generally found to exist in the rocks themselves, in whatever parts of the world they are found. Thus we have a universal and wide-spread formation of *red* coloured sandstone; another is termed *variegated*, from the beautiful varieties of colour which it almost always exhibits; lias is always more or less of a *blue* colour; and chalk of various tints of *white*, the upper parts of the group being distinguished by layers and nodules of flint, which are almost entirely wanting in the lower strata. Now in all these, and numerous other well known peculiarities, the old formations differ so entirely from every thing with which we are acquainted, as to the deposition of such sediments as may now be in progress in the waters, that it is only wonderful how it has ever occurred to geologists to construct theories, and compute periods, from analogy between the two. If such theories are well founded, we are to suppose ourselves now to be in the midst of one of those geological epochs, which are described as having been before, and which will be again, throughout all time. To which, then, of the regular formations are we to liken the group of strata, now in the course of deposition? Is it most likely to be *a white earthy* deposit, as chalk, or a red sandy formation, like some of the best defined strata of the older rocks? Will it prove to be a *calcareous*, an *arenaceous*, or an *argillaceous* formation? Such are the questions which naturally arise in the mind, in reasoning from what *has been*, to what *is*, and *will be*, under the guidance of the existing laws of nature. Every fact with which we are acquainted in the existing march of nature, as to the erosion of rocks, and the deposition of their varied sediments, is directly opposed to the idea of any such universality of mineral character, in the sedimentary formations which are now in progress in the waters of the earth.

There is also another very striking fact to which it may be proper to advert in this place. I mean a like *unity* in the character and position of the *soil* of the earth, on the presence of which, the existence of both animal and vegetable creations so materially depends. This *soil*, or *loam*, is no where found, except where the wonderful design and economy of a Wise Designer foresaw its necessity. I am aware that on the subject of the origin of soils, there are various contending opinions; and a very common idea is, that they have almost entirely arisen from the long-continued action of the sun and air, upon that portion of the surface, and to that particular depth only, which is exposed to this action. But though we cannot doubt that this action of the atmosphere is another proof of design, and that it greatly ameliorates all soils, which, indeed, without it, would soon become barren, it is evident to any one who will examine the sections of that general diluvial covering *which exists only on the surface of the earth*, that those rich soils, generally termed *vegetable loams*, are quite distinct from any thing found amongst the regular strata beneath. This diluvium, being the result of the action of waters, may perhaps be said to be a *mere natural consequence* of such action, and therefore that we cannot justly attribute to express *design*, what any, and every, flooded river produces, on a smaller scale. But inasmuch as *a general Deluge* covering *the whole earth*, exceeds the flooded brook or river, by so much do the *universal* and *preternatural* effects of the former, exceed the *local* and merely *natural* effects of the latter; and thus plainly indicate, in a like proportion, the beneficial *intention* and *design* of the existing arrangements. It has been already shown, that by the derangement and elevation of strata which were once horizontal, the surface of the present earth, *under its diluvial covering*, is composed of all the known varieties of rock, which are thus placed within the reach of man; and that by the beautiful system of valleys, more or less deeply engraved upon these rocks, the facility of attaining them is greatly increased. Any one who has examined the surface of these rocks, in places where the diluvial soils have been removed from them, for the purposes of quarrying, must be aware of the strange superficial disorder and barrenness, which would have resulted from the Deluge, had not all the inequalities been filled up, and every rocky ruggedness been smoothed over, by that wonderful and fertile covering of moved mineral matter, to which almost *alone*, our own country owes its greatest beauty and richness; and without which, scarcely any part of the earth would have been habitable by living animals. It is true, that the present soils which nourish vegetation are not exclusively composed of this diluvium: its depth varies from almost nothing, up to a hundred feet or more; and in situations where it is thin, or altogether wanting, the soils are composed of the detritus of the prevailing rocks, originally softened by diluvial action, and subsequently acted upon by the atmosphere; and their various degrees of fertility must thus depend upon the nature and composition of such rocks. But it is generally in such cases, only by the labour and the ingenuity of man, that the soils are so mixed as to be highly valuable; the sandy soils are too light and dry, while the argillaceous soils are too heavy and wet, for agriculture, without assistance, in both cases, by manures and by draining. It is in the *diluvium* alone, even at a distance from rivers, that those deep deposits of the finest *soils* are found, which, with a proper *natural* mixture of sand or gravel to effect their own drainage, require but little help from the hand of man; and with such soils, of various degrees of richness, probably *nine-tenths* of the whole habitable surface of the earth are covered, as the *beneficial*, and obviously *intended* result, of a destructive judgment.

If such, then, is the difference between the mineral formations of ancient and modern times, what analogy can we draw between the two, as to their organic contents? Are we acquainted with any single instance of *a new shell*, *a new fish*, or *a new vegetable*, having been " called into being" within the periods of man's experience? We can imagine cases of the local disappearance of certain animals, in certain districts. Thus the remains of the wild boar, the wolf, and the beaver, can no longer be deposited as modern fossils, in the British estuaries. That singular bird, the dodo, is now no longer known, although its existence, a century or two ago, is fully attested, by the specimens of its head and feet which have been preserved. Local causes, and especially the presence of man, may in such cases, slightly influence the animal and vegetable kingdoms. But we cannot reason on any such influence, in the cases we are now considering. We are told by geologists, that with the commencement of certain *mineral* strata, certain *animal* and *vegetable* forms also *commenced.* Have we any such *commencements* in the present state of nature? And if we find ourselves entirely deprived of all such points of comparison, by which alone we are capable of judging, are we not naturally led, by the *creative* Power which these animal forms so obviously bespeak, to attribute to the same Power and Will, such changes and arrangements *in the mineral strata,* as appear to have accompanied those changes *in organic beings?* If this inference be just and natural, we cannot, without force, separate, as geologists do, the two facts, and suppose that in the one case, a creative Power was exercised, and that in the other, corresponding as it seems to have done in point of time, the mineral formations were the mere casual effects of the same common laws of nature which are still in force around us. The mutual and oft-repeated correspondence between such changes, is too remarkable to admit of this distinction. We see, *in both,* a complete deviation from *existing nature.* But by existing nature alone, can we form just conceptions of things. In the absence, then, of this sole criterion, we are forced to quit the laws of nature, by which philosophy so tenaciously holds; and we are handed over to a different and superior power, of which we can have no knowledge except that it exists*.

It now becomes necessary to proceed in our inquiry as to facts, and to point out some other inconsistencies in that line of geological reasoning, which leads to the prodigious periods of time, demanded by theorists. One of the most glaring of these inconsistencies, occurs in the theory of the origin of coal. The interesting strata in which this substance, so important to man, is chiefly found, form a page in our book which is very frequently imperfect, or altogether wanting; but when in its complete state, there is not any other, in the whole geological series, the *unity* of which, both in *position* and in *character*, is better defined. Thus we learn, that the same kinds of *strata*, the same kinds of *coal*, and the same *vegetable fossils*, are found in Europe, in India, in New Holland, and in North America*. I have at this moment before me, specimens of fossil vegetables which were sent me from the coal mines in Bengal, identical with plants found in the British coal fields.

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* "Seeking assistance," says an able writer, "from the works of distinguished naturalists, we do not always find that disposition of mind to prevail, which we should be apt to suppose a necessary result of their peculiar studies. It is, above all, surprising, with what perverse ingenuity men seek to obscure the conceptions of a Divine Author, an intelligent, designing, and benevolent Being; rather clinging to the greatest absurdities, or interposing the cold and inanimate influences of the mere elements, in a manner to extinguish all feeling of dependence in our minds, and all emotions of gratitude."—*Sir Charles Bell's Bridgewater Treatise*, p. 142.

The following passage will fully explain the most probable origin of coal: we shall subsequently find, however, the most conclusive reasons, either for rejecting this theory of coal, or that part of it which demands such enormous periods of time, for the deposition of the secondary strata†. "The earliest stage to which we can carry back its origin," says the eloquent author of the Bridgewater Geological Treatise,

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* "The same kind of fossil plants are found in the coal mines of North America; and we have reason to believe that similar remains occur in coal formations *of the same epoch*, under very different latitudes, and in very distant quarters of the globe, as in India, New Holland, Melville Island, and in Baffin's Bay."—*Buckland's Bridgewater Treatise*, Vol. I., p, 479.

† Amongst various geological errors, to which I have myself to plead guilty, that respecting the diluvial origin of coal, is one of the most important. I was formerly led too hastily to adopt this idea, in the obscurity which was, and still is, so palpable, with regard to this interesting member of the series. Feeling assured of the *fact* of the Deluge, (though then entirely ignorant of the *proofs* of it which have now been disclosed,) and satisfied that it occurred only *once*, in the history of our planet, I was led to connect this *unity*, with that above described, as belonging to the coal strata, and thus to reason on the probability of some connection between such *cause*, and such *effect*. Subsequent study from nature, has convinced me of the error of that hypothesis.

"was amongst the swamps and forests of the primeval earth, where it flourished in the form of gigantic *calamites*, and stately *lepidodendra* and *sigillariæ*. From their native bed, these plants were torn away, *by the storms and inundations of a hot and humid climate*, and transported *into some adjacent lake, estuary, or sea*. Here they floated on the waters, until they sunk saturated to the bottom; and, being buried in the detritus of adjacent lands, became transferred to a new estate, among the members of the mineral kingdom. *A long interment followed*, during which, a course of chemical changes, and new combinations of their vegetable elements, have converted them to the mineral condition of *coal*. Yes *By the elevating force of subterranean fires*," (that is, by common earthquakes,) "these beds of coal have been uplifted from beneath the waters, to a new position in the hills and mountains, where they are accessible to the industry of man*."

There can be no great objection found to the above theory as to *the formation* of coal. It bears an appearance of truth upon its front, which seems corroborated by the fossils, and the mineral beds in which they are deposited. It is, however, completely destructive of the theory of "*millions* No *and millions of years*," and of "*myriads of ages*," of which its author elsewhere speaks, with reference to the secondary strata. I cannot better point out this glaring discrepancy, than by reference to other parts of the same theory, in the same work. Thus, (at page 65, in a note,) we learn, that "the causes which collected these vegetables, in beds thus piled above each other, and separated by strata of *vast thickness*, composed of drifted sand and clay, *receive illustration* from the manner in which drifted timber, *from the existing forests of America*, is now accumulated in the estuaries of the great rivers of that continent." Geological writers invariably point to these great deposits in the American lakes and estuaries, as distinct examples of coal deposits, for the study of future geologists. It is singular, however, that we hear of no such deposits of any importance, in any other country; and nothing of the kind is known in our European lakes or estuaries. Such instances are, no doubt, both interesting and instructive to the geologist; but if such *woods, rivers, lakes*, and *estuaries* have existed during "millions of years" in tropical climates, between that time and this, in the course of which, the whole intervening series of rocks has been deposited, *by an action which*, we are told, *has ever since existed, and is still seen in force in America*, we may naturally be allowed to ask why such deposits of coal are not irregularly interspersed *throughout the whole series of rocks*, and why that valuable deposit of mineralized vegetable matter is never found, to any extent worth speaking of, *except* ONCE *in the whole structure of the earth?* Can it be supposed, that

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* *Buckland's Bridgewater Treatise*, Vol. I., p. 482.

only at the two extremities of these "myriads of ages," "swamps and forests, in hot and humid climates," have suffered from storms and inundations, to an extent sufficiently great, to produce deposits of vegetable matter? And yet, if we are to adopt this theory of boundless periods, such must have been the case; for we are correctly informed by the same authority, that "our grand supplies of fuel are derived, *almost exclusively*, from the strata *of the transition series.* Examples of coal in the secondary strata *are few and insignificant;* whilst the lignites of the tertiary formations, although they *occasionally* present *small deposits* of compact and useful fuel, exert no important influence on the economical condition of mankind."—Vol. I., p. 524. In like manner, the same author, while urging the necessity of economy in the working of the coal mines, describes the coal strata as of but "*limited amount,* which, when once exhausted, *are gone for ever;*" (p. 537) and yet these limited and precious deposits are attributed to such laws *as now act in the American lakes, and which have acted throughout the whole periods of the formation of the tertiary and secondary rocks!*

Now, in this dilemma, there seems to be a necessity for giving up either the above theory of *the mode* of the coal formations, or that of the *immense periods* which are said to have succeeded them. For my own part, I would willingly follow any simple and obvious path, which runs parallel with the laws of nature; but when this, the only guide to scientific knowledge is lost sight of, we are in imminent danger of falling into obscurity and error. Our only safe refuge, in such a case, is in that Power which Revelation has exhibited to us, and which we know has acted with preternatural effect, on the mineral structure and configuration of the earth, and that, too, within a comparatively recent period. If difficulties occur then, on such subjects, which our reason cannot readily fathom by the exercise of *comparison*, (the only medium by which human judgments can be formed,) it is surely more consistent with the submission due to that Power with which we have to deal, tacitly to resign our imperfect judgments to what He has been pleased to reveal to us, than to persist in plunging ourselves, and above all, others, into inextricable errors; and by ineffectually attempting to bend *His Sacred Revelation* to *our own fanciful* X *theories*, thus rudely to shatter the very foundation of our belief on other points, of incomparably greater importance than geology, to the present as well as future well-being of the human race. As far as second causes will lead us, *there* we can and ought consistently to follow. But we can only judge of *their power*, by what we have seen of *their action*. In the cases in question, in the mineral structure of the earth's surface, the results of what we regard as second causes, or the laws of nature, (though on a scale totally different from what now exists in force,) is so intimately mixed up with phenomena of organic beings, which must necessarily be referred to a *final*

x as this man does

cause, that we cannot readily draw a line of distinction between the two. Thus a flood may be a result of a second cause; and to a certain extent, we feel no need of a reference to a final cause in accounting for it. But when we find such complete demonstration as we now possess, of such a Flood as has produced effects far beyond any thing we can conceive of the power of second causes, we have no resource left, but a reference to *a first cause*. In judging of the effects of second causes, we cannot follow a sounder path than that pursued by Newton, in working out his sublime demonstrations, "It was a distinguishing character of his great mind," says Dr. Chalmers, "that it kept a tenacious hold of every position which had *proof* to substantiate it; but a still more leading peculiarity was, that it put a most determined exclusion on every position destitute of such proof. He kept by his *demonstrations*, his *measurements*, and his *proofs*." It would be well for geology, if such were the solid foundation on which any one of its numerous theories of the earth had been constructed*.

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* "The object of all science," observes Dr. Abercrombie, "whether it refers to matter or to mind, is simply to ascertain *facts*, and to trace their relations to each other. The powers which regulate these relations are entirely hidden from us, in our present imperfect state of being; and by grasping at principles which are beyond our reach, we quit that path of inquiry which is alone adapted to our limited faculties, and involve ourselves in error, perplexity, and darkness."—"They who have made the

We must now refer to one or two other striking facts, which also appear distinctly opposed to the theory of vast periods of time having elapsed, during the deposition of the sedimentary strata. The first of these facts appears in the form of numerous stems of large and lofty trees, deposited chiefly in the coal strata, but also found in others of the secondary and tertiary beds, *in positions different from the direction of the strata*, and forming angles with the lie of the beds, varying from nothing, up to ninety degrees. In some instances, these have been observed *from forty to seventy feet in height*, and thus intersecting many different strata, to the deposition of *each* of which, in the absence of such vertical witnesses to the contrary, considerable periods of time would certainly have been attributed. It has sometimes been attempted to be shown, that such trees may have *grown* where they now stand. But to this idea, which, even if it were just, would not invalidate the proofs of *rapidity* in the deposition of the embedding sediments, there are several conclusive

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highest advances in true science, will be the first to confess how limited are our faculties, and how small a part they can comprehend of the ways of the Almighty Creator. They will be the first to acknowledge that the highest acquirement of human wisdom is to advance to that line which is its legitimate boundary; and, there, contemplating the wondrous field which lies beyond it, to bend in humble adoration before the Wisdom which it cannot fathom, and the Power which it cannot comprehend."—*Abercrombie on the Intellectual Powers*, p. 21.

objections. The first is, that the stems are almost always deprived both of branches and of roots, and often bear the plainest marks of violence, as if transported by water from some distance*. Nor, even if the roots existed, can we conceive any analogy in existing nature, to such burial; for in what situation, in our woods or marshes, can we look for depositions capable of covering up entire trees, *as they stand*†? The second objection is not less conclusive; for had they grown in certain beds, the roots must all have been seen, *in these particular strata;* whereas the stems lie at various heights, nor are they always perpendicular; and a tall stem, without either roots or branches, deposited in a vast mass of sedimentary matter, at an angle of only 45° with the lie of these strata, is a stronger testimony to *rapidity* in the deposition, than even an *upright* stem; for while the latter might be supposed to have been capable of retaining an upright position, in a semi-fluid mass, for a long time, by the mere laws of gravity, the other must, by the very same laws, have fallen, from its inclined, to a horizontal position, had it not been retained in its inclined position, by the rapid accumulation of its present stony matrix. Now, besides the impossibility of discovering, in existing nature, any stem of a tree, likely to stand for *hundreds*, or for *thousands* of years, to be thus slowly interred, we can no where conceive such abundant accumulations of sedimentary matter to be now in progress, in *short* periods, without their producing changes, even in the deep bed of the sea, which would be most obvious, even during the life of man. If we take, by way of example, the deposits of the river Nile, which is well known to have always been remarkable for the regularity of its inundations, and the turbidness of its waters, we find that but little change has been effected by it, during the historic periods, which extend, in that instance, beyond those of any other country where architectural monuments have been left, by which we can form a conclusive judgment. There have always been *Nilometers*, by which to measure the rise and fall of the waters; and the present one is a marble pillar, which stands in a deep square basin, its base having been the level of *Low Nile*, at the period of its construction, (A. D. 847.) It has been ascertained by these evidences, that the additional deposits of sediment in the bed of the Nile, in its delta at Cairo, have not amounted to more than about *five inches in a century*. And, although the change may be somewhat more rapid in the sea, in more distant parts of the estuary, yet, the changes in the soundings, and in the whole form of that coast, must have been most obvious and well defined, had the deposits, in the slightest degree, resembled those strata in which coal is found. It also becomes obvious, that if vast rapidity of deposition can thus be proved, with regard to such strata as are thus seen intersected by tall and vertical stems, we are fully justified in attributing a similar rapidity to all the coal strata, or other formations, which are similar in their other phenomena, though perhaps deficient in such interesting natural chronometers.

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* In the instance of a very large and highly inclined stem lately discovered in Craiglieth quarry, near Edinburgh, a small part only of which has yet been exposed, there is every appearance of its root end, or thicker extremity being *upwards*. Should this prove to be the case on a deeper inspection, it will for ever put an end to the idea of such vertical stems *having grown* where they now are. But by the laws of gravity, this inverted position, if it ever do occur, cannot but be rare, as the stem of a heavy tree, especially if it be long, and have consequently a great disproportion between the weight of its two extremities, would naturally sink in a fluid, and perhaps still more, in a semi-fluid, with its root end downwards.

† Dr. Macculloch informs us that "a Scottish lake does not shoal at the rate of *half a foot in a century*."—*System of Geology*, Vol. I., p. 507.

The second fact to which I proposed to allude, regards that *universal transition, or gradual passage from one sedimentary deposit to another*, as seen at the point of contact. In this fact, to which allusion has already been made, we have perhaps the strongest proof that can be adduced, of *an uninterrupted aqueous deposition*, throughout the whole formation of the earth's strata: and as, in the comparative value of geological evidence regarding *time*, the phenomena of the rocks themselves must, of course, take precedence of those of the organic beings that may chance to be embedded in them, we must not suffer ourselves, as some have too frequently done, to be led away by these latter, from the point at issue. It has, indeed, been frequently admitted, that, but for the fossil contents of rocks, there could be no strong argument advanced, in support of long periods of time. The supposed periods have been *assumed,* chiefly from judging of these fossils by analogy with the settled character of existing races; but we have already shown that there can be no just analogy drawn between the two. The phenomena of the *rocky matrix* are of more importance with regard to *time,* than those of the objects which have been embedded in it: for if the former clearly bespeak not only *rapidity of deposition,* but also an *uninterrupted continuance* of that deposition in water, the latter must necessarily adapt themselves to this state of things, however difficult we may find it to reconcile them, by the established rules of nature *as we now see it.*

These insensible transitions between the secondary rocks, were first pointed out to me by an eminent professor of geology at Paris, during an examination, under his guidance, of the tertiary strata of the Paris basin. In the course of an agreeable and most instructive excursion, in the environs of that city, we visited various points, well known to his experience, where the facts *at the points of contact,* are so striking and simple, that he had long been opposed to the theory of Cuvier and others, who conceived the strata of that celebrated basin, to have been deposited at various wide intervals of time, and this chiefly on the strength of the variety of fossil remains, which are embedded in them, without any regard to the facts exhibited *by the sedimentary deposits themselves,* which plainly bespeak a different mode of origin. Since my attention was thus called to this most important point in the sedimentary deposits of the earth's surface, I have had ample opportunities, both in Britain and on the continent of France and Germany, of inspecting the junctions of almost all the formations; and I feel persuaded that there is no fact more clear in geology than this, *viz. that the upper surface of almost every formation, was yet soft and moist, when the superincumbent sediments were deposited upon it.* This was clearly the fact, in the case of all the tertiary strata around Paris; and the same may be seen in the Isle of Wight, and in the south-eastern cliffs of England. Many similar junctions may be seen on the eastern coast of England, in the secondary strata below the chalk. I have already alluded to a beautiful series of such transitions, from the old red sandstone in Forfarshire, through the schist rocks, *into pure granite,* around Aberdeen*.

This important geological fact has, as yet, been but little noticed by geological writers; and the sharp outlines, in all the drawn sections, are further calculated to mislead the student, who may not have it in his power, or to whom it may not occur, to inspect, in nature, these points of contact. That the fact is strongly opposed to existing theories, is evident: for those theories teach us, that during an incalculable lapse of ages, occupied in the deposition of these strata, many, or most of the different formations, were, at such long intervals as our own historic periods, or even much longer, in the form of dry lands, supporting a rich vegetation, though for the most part unoccupied by land animals, they not having yet been "called into existence."

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* See page 285.

In complete accordance with this fact, we find similar proofs of *uninterrupted* deposition, in the junctions of all the individual strata of each formation or group. These strata vary from one inch or even less, *to four or five feet* or more, in thickness. On raising a bed of sand or limestone in the quarry, we almost always find corresponding *inequalities*, which plainly bespeak the *softness* of the lower bed, and the yet greater softness of the upper one, at the period of their deposition. These inequalities have frequently all the appearances which are seen on sand or mud-beds in existing waters. The marks of water-ripple are very frequent, and are often as distinct as on the present sea shore at the ebb of tide. Every one knows how evanescent are such marks, and that a few hours of sun, or wind, are sufficient to obliterate them. Such marks are never seen, however, in rocks, except at the partings of the strata; and they seem thus also to bespeak a certain *periodical* deposition, as of an ebb and flow, though we cannot discover in the existing waters, any depositions at all similar in amount, with which to compare them. For if we consider for a moment our most remarkable sand-banks, or muddy estuaries, we shall find that but little visible addition has been made to their depth, during hundreds of years past. Thus the changes which have occurred in the well-known Goodwin Sands, seem to have been limited, during the last three hundred years, to the shifting of some of its spits, or projecting points, during heavy gales of wind, and, perhaps, to small additions in its horizontal extent. As for our estuaries, we know that though ripple-marks are left upon their muddy or sandy surfaces after every ebb tide, yet these are instantly obliterated on the ensuing flow; and this not by *additional sediments* being embedded upon them, but simply by the fresh movements of the advancing waters. In the muddy and extensive estuary of the Stour, in Sandwich Bay, for instance, and also in the yet more extensive deposits of mud and sand in the mouth of the Thames, the tides have ebbed and flowed during the last twenty centuries, without effecting a change, *by deposition*, of more than, at the very utmost, five or six feet of perpendicular depth. The greater part of the secondary formations of the earth, in which these phenomena are observed, are in beds or strata of the average thickness of from twelve to eighteen inches. In many of the sandstone quarries, we find strata of much greater thickness, having these unequivocal marks of *uninterrupted rapidity*, impressed between every two beds, to a very great thickness.

It is in such situations, and especially between the strata of the red sand-stone formation, that, in addition to the ripple-marks above mentioned, various *tracks of animals*, have from time to time been discovered. In addition to those which were first discovered in Dumfries-shire, and which were attributed to turtles, other still more remarkable instances have of late been described; and a splendid specimen of one of these tracks has lately been placed in the British Museum. This latter is one of many which were discovered by M. Alexander Von Humboldt, in the variegated sandstone, at Hildburghausen, in Saxony. The tracks are, in this instance, those of *quadrupeds*; and this is the more remarkable, as no bones have ever yet been discovered, in these beds; nor were quadrupeds previously supposed by geological theorists, to have been in being at the period of this formation, or even of many subsequent formations. In the large slab in question, there are various tracks; and, at first view, one might conclude, from the different sizes of the footmarks, that an old animal and its young had passed over the mud bank, while yet soft. A little further study, however, shows that this difference was not one of *age* or *size* in the animals, but that the fore feet were very much smaller than the hind; for they both follow each other at regular intervals; instead of which, had there been a large and a small animal, the distance between the steps of the smaller, must have been in proportion less. In this instance, the larger footmarks measure about four inches across, and the smaller not more than two. Some footmarks have been found which were twelve inches long. In those of the British Museum, the animals have walked leisurely over a bed of soft *mud* or *clay;* and we see around each foot print, the rough, elevated ridge of clay, which the pressure of the foot occasioned. Upon this bed of *mud*, a deposition of *sand* took place; and it is this impression *in alto*, on the indurated sandstone, that we now examine; an artificial cast being placed alongside of it, to show the appearance of the original track on the *mud*, which has not been preserved.

These *fossil footmarks*, if we may so call them, may certainly be regarded as amongst the most remarkable and instructive of all the phenomena of our strata. When we discover the *bones* of an animal, we may conceive, it is true, that animal walking, and leaving a track behind it. But still the animal when in life, may have inhabited a distant region, and its carcass may have been drifted from we know not where. But in the case of foot tracks, we are brought *almost into the presence of the living animal.* Like the sportsman who, in the eager pursuit of his game, expects, from the freshness of the foot prints, to find it, at any moment, within his reach, we almost fancy our having seen the large and unwieldy creature, which, in this case, has, *so lately* as it were, passed before us. We have also some faint idea even of the very scene on which he moved. That it was *a mud bank, periodically dry*, seems certain, from the beds of a similar character *above and below it*, in the quarry. That it was but *a short time dry*, seems equally clear, from the freshness of the foot prints. That the surrounding waters were extremely *turbid*, we may plainly infer, from the fresh and abundant deposits of sand, on the very first subsequent flow. But what shall we say of the *extent* of the surrounding shoals? There is no geological formation more clearly defined, or more *universally* recognised in the series, than this particular sandstone. Could we, therefore, follow *the individual stratum*, on which these foot prints are found, it is not easy to define its probable extent or termination. To what, then, shall we liken it, in modern times? and where shall we look, in existing nature, for a situation, where we might walk on mud beds *raised two or three feet higher, after every periodical flow of the tide*, and this not for one or two tides only, but for periods capable of thus accumulating sediments *of some hundreds of feet* in thickness? When such situations, and such a state of things, are discovered on the existing earth, then, but not till then, shall we be justified in reasoning *as to what has been*, from strict analogy with what is now going on before our eyes.

In the *Bridgewater Treatise on Geology*, an interesting account is given of the various instances of such tracks which have been discovered both in Europe and in America; and the following beautiful reflections have arisen from the contemplation of those tracks of tortoises, which were first discovered in Dumfries-shire. "The historian or the antiquary may have traversed the fields of ancient or of modern battles; and may have pursued the line of march of triumphant conquerors, whose armies trampled down the mightiest kingdoms of the world. The winds and storms have utterly obliterated the ephemeral impressions of their course. Not a track remains of a single foot, or a single hoof, of all the countless millions of men and beasts, whose progress spread desolation over the earth. But the reptiles that crawled upon *the half-finished surface of our infant planet*, have left memorials of their passage enduring and indelible. No history has recorded their creation or destruction; their very bones are found no more among the fossil relics of a former world. *Centuries*, and *thousands of years* may have rolled away, between the time in which these footsteps of tortoises were impressed upon the sands of their native Scotland, and the hour when they are again laid bare, and exposed to our curious and admiring eyes*. Yet we behold them stamped upon the rock, distinct as the track of the passing animal upon the recent snow; as if to show that thousands of years are but as nothing amidst eternity; and as it were in mockery of the fleeting and perishable course of the mightiest potentates among mankind*."

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* We cannot fail to be struck with the hypothetical way in which the eloquent writer of this passage here speaks of the *hundreds* and *thousands* of years that *may* have existed, between that time or this, after the free use of *millions and myriads* of years, previously applied to the secondary formations. The *half-finished* state of our infant planet, also gives the idea of its now being *quite*

Such marks, then, and such easy transitions, when found in the midst of the vast accumulations of sedimentary matter which compose the surface of the present earth, and especially when combined with the occasional plain testimony of the *rapidity* of former depositions, displayed by tall and highly inclined stems, *intersecting many strata,* form a combination of evidence which forcibly breaks through all attempts at analogy with the existing march of nature. This seems, indeed, to be occasionally admitted, even by those who theorize on periods of countless ages, solely on the strength of such analogy. Thus we find the author of the same *Bridgewater Treatise,* describing the accumulations and transport of sedimentary matter which form the secondary strata, as having taken place "on a scale of magnitude, *unexampled* among the actual phenomena of moving waters;" (Vol I., p. 68) of "rains, torrents and inundations, *at that time* probably acting *with intense*

finished; whereas the theory of *gradual refrigeration,* and endless successions *of creations* in the organised world, supposes the globe to be only *now* in one of its stages towards future and similar changes.

* *Bridgewater Treatise on Geology,* Vol. I., p. 262.

violence;" (p. 51) of "the *turbulent* condition of our planet, whilst stratification was in progress;" (p. 126) and of "gigantic lizards, fitted to endure *the turbulence*, and CONTINUAL *convulsions* of the *unquiet surface* of our infant world;" (p. 166) and yet, we are told that we ought to judge of the *mode* in which the existing state of the earth's surface was fitted, as it now is, for man's abode, by the very same rules which now appear so fixed and established in nature, only allowing *time* for the process, on the same disproportioned scale!

Having now stated a few of those objections on which I ground my own protest against such unbounded theories; and having shown, what appear to my own mind at least, clear and insuperable objections to the idea of the earth's former surface having been *many times* submerged, and *repeatedly* remodelled from sea to land, and from land to sea; it only remains for us to examine attentively the phenomena of the Deluge, of which we have now such clear demonstration over the entire surface of the present dry lands, in order that we may be enabled to judge whether it was *the only event of the kind*, to which the globe has ever been subjected; or whether, on the other hand, those geologists are right, who contend that it was only *the last of many such convulsions*.

On this important part of our subject, I conceive that we are strictly confined within very narrow and well defined limits. For as we know that *like causes* must always produce *like effects;* and as we have established the fact, on the most unequivocal physical evidence, that an event of recent occurrence has raised all the present dry lands from the bottom of the sea, and left them *grooved out* and channelled over their entire surface, with innumerable valleys of every size; we cannot fail to perceive that if such interchanges of sea and land have repeatedly occurred, during the formation of the secondary strata, we ought, in like manner, to find in some, or in most of the extensive sections of these formations displayed on our sea coasts, well-defined proofs of *similar diluvial effects,* impressed upon what are generally described as having been *former habitable surfaces.*

In order to show, by an example, what we ought to expect in this latter case, let us suppose the Isle of Thanet, or the Isle of Wight, as they have been already described, sunk to the bottom of the ocean, in the same unbroken and but slightly-disturbed condition, in which vast tracts of land became dry, at that period of interchange which we have now established. In such a case, their surfaces would remain as they now are, or nearly so, that is, *universally undulating,* and varied by well-defined *diluvial valleys.* In this new position, submerged, by whatever means, in the ocean, new sediments would be deposited, of various kinds, and probably different both in colour and consistency, from the chalk and other strata of which they are now composed. We may further suppose, that after "*the usual inter-*

vals" between *natural* deluges, a second change takes place between sea and land, and that we thus have it in our power, to examine our long lost islands, together with the *new strata* which have been deposited upon their surface; extensive sections are soon formed upon the new sea-coasts; and the old and the new deposits thus become completely laid open for our inspection.

In such an hypothetical case, it is very certain that our attention would be first attracted, in examining a long line of sea cliffs, to the well defined outlines of the *ancient diluvial valleys*, now filled up to a general level, with new and different coloured strata. In examining the points of contact between the old and the new depositions we could discover no such *ripple marks*, or *foot tracks* as have been above described; nor the smallest *transition* between rocks that were already indurated, and the soft sediments subsequently deposited upon them. There could be no such connecting links between the two, as tall stems embedded *in both*. But the sections of *valleys* of every size, could not fail to come frequently into prominent view; phenomena which we in vain look for, in any of the sections of our secondary strata. Now if like *causes* produce like *effects*, such marks of *ancient valleys* ought to be of constant occurrence in geological sections, as the natural results of *former* deluges, if such deluges really have formerly occurred. It is in vain to suppose that many of the slopes in the existing sections may have been the sides of valleys too wide to admit of our seeing the whole; or that the *basin*-shaped hollows, so well known in geology, have any relation to real *valleys;* for though we know from soundings, that such basins and their intervening heights, as well as extensive *plains*, and other varieties, exist abundantly in the bed of the sea, yet there can be no *valleys*, properly so called, under the level of the waters, simply because the *cause* is there absent, which could alone produce such *effects*, *viz.*, a powerful flow of *descending* waters. In the numerous and extensive sections of rocks, which have passed under my own observation in different countries, I have never seen a single instance of a well-defined *ancient valley*, on the subterranean surface of any individual formation: and when we consider, for a moment, the *universality* of such valleys, on the existing surface of the earth, all arising as we now know, *from a recent interchange from sea to land*, and from the consequent drainage of the waters of the earth into a new bed, we surely cannot be justified in reasoning *on the repeated occurrence of like causes*, unless we can ground our reasonings *on the repeated existence of like effects*, as seen in the secondary strata of the earth*. We must therefore conclude, in the total absence of such proofs from our geological sections, that no such event as has produced the endless varieties of form on the *present* surface of the earth, had ever occurred to the *subaqueous surfaces* of any of the sedimentary formations. We cannot indeed doubt, that former dry lands did somewhere exist; for we have abundant organic remains embedded in the strata, which must have belonged to former dry lands. But we have no distinct evidence in the present earth, to indicate *where these lands were situated;* and when we consider that the existing continents occupy but about one-third of the whole superficies of the globe, we have ample space for the supposition, that during

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* Amongst the most striking effects of the Deluge, and the consequent excavation of valleys, on the present surface, we may include the disclosure of those caves and fissures, in certain calcareous rocks, which almost all now contain more or less of diluvial matter, mingled with fossil remains. As these caves *themselves* were evidently not occasioned by the action of the waters, we

cannot doubt but that similar cavities would be found in such strata, far below the present surface of the earth, if we had occasion to search for them at such depths; and they would, in such a case, be entirely unconnected with the present surface, and free from the *diluvium* of this *last* deluge. The question then naturally occurs, in searching for evidence of *former* deluges, whether such diluvial and fossil deposits have ever yet been discovered in caverns or fissures *unequivocally excluded, by subsequent rocky formations*, from all connection with the effects of the last deluge?

Connected with the same subject, and in the confident belief that the calcareous matter called *stalagmite* and *stalactite*, is a *post*-diluvial formation, which could not be produced till the rocky cavities in which alone it occurs, were freed from the waters, we may also inquire whether such stalagmite has ever been found in diluvial gravel, and has thus borne testimony to its ante-diluvian existence? I am not aware of the actual existence of the facts, in either case; but the evidence of the former would be infinitely more instructive than that of the latter.

the great interchange of sea and land which occasioned the Deluge, the old continents were entirely submerged, and are thus for ever placed beyond the reach of geological inspection and study*.

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* Having had occasion, in the preface to this volume, to mention the change of opinion which had been some time since expressed, on the subject of the deluge, by a President of the Geological Society of London, in his address to that body (in 1834), it may be interesting to the reader to be made acquainted with the latest opinions of scientific men as to that event; and with this view, I take this opportunity, in concluding this Treatise, of making the following quotation from the address of the late President of that body, on resigning the chair (February 1837): "I cannot take leave of this subject without remarking that the occurrence, in various parts of Ireland, Scotland, and England, of recent shells in stratified gravel, sand, and loam, confirm the opinion which I derived from an examination of part of Sweden, namely, that the formations usually called *diluvial*, *have not been produced by any violent flood*, or *débacle*, or transient passage of the sea over the land, *but by a prolonged submersion of the land*, the level of which has been greatly altered, at periods *very modern* in our geological chronology. I now believe that by far the greatest part of the dispersion of transported matter has been due *to the ordinary moving power of water*, often assisted by ice, *and co-operating with the alternate upheaval and depression of land*. I do not mean wholly to deny that *some sudden rushes of water, and partial inundations of the sea* have occurred; *but we are enabled to* DISPENSE WITH THEIR AGENCY *more and more, in proportion as our knowledge increases*." In passing a high and well merited eulogium on the descriptive parts of the *Bridgewater Geological Treatise*, and in differing with its author on some theoretical points, the late President thus continues: "His work is admirably adapted to convey instruction on organic remains,

Let us now, in conclusion, take a summary retrospective glance, at the whole line of physical testimony which has been adduced throughout this Treatise, in order the more clearly to perceive the line of direct inferences, to which we have been naturally conducted.

1*st*,—In the first place, then, we find, from the universality of *stratification*, that all the sedimentary matter composing, to a depth of several thousand feet, the surface of the present dry lands, has been arranged, as we now see it, *in, and by the action of, water*. From the great prevalence of *marine* exuviæ throughout the strata, we have a right to conclude that this water was that of the ocean, although the intermixture of occasional remains, apparently belonging to fresh waters, leads to the inference, that collections of

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and other departments of geology, both to beginners and to those well versed in the science; and is characterized throughout by a truly *philosophical* spirit, which betrays no desire *to adhere tenaciously to dogmas impugned or refuted by the modern progress of science*. On the contrary, the author has abandoned several opinions which he himself had formerly advocated; and although still attached to the theory which teaches the *turbulent* condition of the planet, when the lias and other fossiliferous rocks were formed, and the general *insufficiency of existing causes* to explain the changes which have occurred on the earth, he yet refers, in almost all parts of his book, *to the ordinary operations of nature*, to explain a variety of phenomena, ONCE SUPPOSED *to be the result of causes different in kind, from those now in action*."

such water also formerly existed somewhere; and that estuaries of rivers must have formed, as at present, the probable receptacles of former terrestrial debris.

2nd,—On a minute inspection of the *junctions* of all strata, we find the strongest testimony, in proof of the *uninterrupted* deposition of the sedimentary matter composing them; and also of this deposition having taken place *with such rapidity*, that the ripple and other water marks of one bed, had not time to be destroyed by the action of the air, or the waters, before they were covered up, and for ever preserved, by subsequent similar depositions, in superincumbent beds.

3rd,—We have other not less conclusive, though less universal, proofs of such rapidity, in the occasional *stems of tall plants, intersecting many different strata,* and placed at various angles, from horizontal to vertical; these strata being frequently of two or three feet in thickness, and bearing ripple and other water-marks between the strata, thus indicating a sort of *periodical deposition and repose*, somewhat resembling the ebb and flow of the tide, but different in degree, and in consequences, from any effect of existing action which we can discover in nature.

4th,—As all these strata bear self-evident marks of a degree of rapidity of formation, of which we can, from the existing state of things, form no just conception, we are not justified in attributing to them periods proportioned to the present comparative repose of nature; and in thus theorising on vast and indefinite periods of time, as the age of the earth. It is by *comparison* alone, that we can judge of either time or space. If we are deprived, then, of such power, from the absence of this only true scale, we become liable to the most erroneous impressions, by drawing our conclusions *from false premises;* and much of that obscurity, which is usually admitted as being characteristic of geological theories, may probably have arisen from this mistaken course.

5th,—As all the visible sedimentary strata of the earth's surface bear unquestionable marks of their having been formed *in water;* and as they are not now submerged, but form, on the contrary, *dry lands;* it follows that there was *a certain time,* when the change took place *from sea to land,* and when they thus *first* assumed their new, and their present character.

6th,—We arrive at the knowledge of this interesting period by two different lines of evidence, each terminating in the same corresponding result. First, by the action of all water-falls, which necessarily *began* their present friction, *on the very first day that the rivers flowed,* and, consequently, *on the first day* that rain fell upon these *marine* sediments *as dry land.* Secondly, by the retrogressive action of the waves upon the sea-coasts, which, in like manner, could not break upon these sedimentary shores, until they became elevated into dry lands; but which, *from that day to the present,* have never ceased to invade the lands, and that with a force in exact proportion to the exposure of such lands to this action.

To attain a knowledge of the real periods of such action, all that is necessary is, to ascertain with conclusive certainty, *the original forms* of the resisting rocks, in both of the above cases; and to form a correct estimate of the rate, at which these ceaseless natural mechanisms are now working, in a given time. In the case of *all* water-falls, we find a general *negative* testimony, distinctly opposed to the theory of long periods of such action; while in the remarkable case of the greatest of all known cataracts, that of Niagara, we are distinctly led to a period, which cannot, by any argument, be made to exceed *ten or eleven thousand years;* but which we have shown, by the strongest natural testimony, to be more consistently computed at not more than about *one half of that time*, or even less.

In the case of sea-cliffs, we have discovered a still more definite result; and they, in like manner, plainly bespeak a period of not more than about *five thousand years*, since the day when *the* FIRST WAVES *broke upon the new and smoothly sloping shores.*

7th,—By these clear natural evidences, we are thus conclusively led to the period when the sedimentary strata which compose the existing dry lands, were elevated above their native waters. We find, moreover, as these evidences are not merely *local*, but are *universal*, that a great and general interchange between the former seas and lands, is clearly indicated, and that about the period of five thousand years ago. Thus far we are conducted to our results, by physical facts alone, and by a line of simple inductive reasoning from these facts, out of the track of which it seems difficult to wander. We cannot here, however, fail to remark the singular coincidence, both in facts and in dates, between these links of physical evidence, and the History and Traditions of various nations, which all speak with more or less clearness, *of a great aqueous catastrophe*, by which the old earth or dry land was covered with waters above the highest mountains; and during which, a general destruction, with but a few exceptions, took place among the living tribes. The date of this event corresponds so nearly with the results of our *natural* testimony, that no candid mind can hesitate in concluding that the two lines of evidence, (that is, *written or traditional*, and *physical*,) relate *to one and the same event;* and thus, that the Deluge described in the Inspired Writings, and handed down by tradition, even in the most remote corners of the globe, is identical with the great interchange of sea and land, to which our *cataracts* and *sea-cliffs* universally bear testimony. At this point of our argument, when the present *diluvial* covering of the whole earth can be clearly assigned to this particular period, we naturally recur to the series of remarkable facts of which a slight outline has already been given, in the first chapter of this treatise. We look back to the remains of *those* THOUSANDS *of elephants, and other large animals*, which are embedded in it, *and in it alone.* We review, also, with redoubled interest, the facts which present themselves in caves, and especially the deposits in the fissures of the Köstritz quarries, where *human remains, in a detached state, are found mixed up with those of large animals, avowedly fossil;* and where no doubt can now exist of the identity of the period when that deposit was lodged there, and when the whole of that country, in common with other smooth and rounded districts, was moulded into its present sloping and beautiful forms.

8*th*,—This fact being proved, and the truth of the so long *doubted, and now rejected* Mosaic Flood, being thus attested, we look around us, into the beautiful volume of the laws of nature, as far as that volume has been graciously unsealed for our perusal, to discover some *law* by which this great event could have been brought about, that we may not unnecessarily have recourse to a *Final Cause,* where *second causes* might be found capable of accounting for the phenomena. But although we find a variety of destructive causes, such as volcanoes, and local floods occasioned by earthquakes, exercising considerable violence in different parts of the earth, throwing up islands from the bottom of the sea, and perhaps even slightly influencing the relative level of sea and land over a limited extent; although we may admit, to the very utmost, the extent of these results, (which are, however, often still but problematical) we look in vain for any *law of nature,* by the action of which, even a small district like the Isle of Wight, *could be at once elevated to the height of several hundred* *feet*, above the level of its native deep. How much more hopeless, then, the discovery of *a law* which could cause the seas and continents of our planet *to change places*, and this not by a very slow and *gradual*, but by a *paroxysmal* movement! And yet so different has this movement been, from any thing that we know *of volcanic effects*, or of terrific and instantaneous earthquakes, that instead of such confusion as these latter almost always occasion, we find an order, a beauty, and a general smoothness pervading the new dry lands, which all bear testimony to the fact, that the *Final Cause* to which we are thus at length driven, could produce, and has produced, the most admirable *good* out of *evil*, and the utmost possible *order*, out of the most awful and destructive judgment.

9th,—Having thus shown, that to no *second cause* can we possibly attribute such wide spread and general results as our physical evidences every where denote; and being thus (however contrary to the more common results of geological inquiries,) forced to refer to a *First Cause*, in accounting for phenomena of comparatively recent occurrence; we are next led to inquire, whether this great event is *the only one of the kind* with which the earth has ever been visited; or whether, on the contrary, it was only *the last of many such* *events*, as philosophers have of late, more generally imagined. In this part of our inquiry, we have but little scope for reasoning, after the result to which we have been led, in our last position. For having no objects of comparison from which to judge, except those prominent features imprinted on the earth's present surface, by the last Deluge; and these features presenting themselves, in the form of valleys of every size, channelled out from the solid mass of sedimentary matter, and often intersecting several different and distinct formations, *otherwise undisturbed;* the only means of judging within our reach, is to examine whether *similar effects* are exhibited in any other part of the sedimentary series of rocks which compose our existing lands. It will probably be admitted by every practical geologist who has studied from nature, that no *similar proofs* of such effects are to be found in any known geological section; and therefore, in the absence of such *effects*, we have no consistent ground for reasoning on former similar *causes*.

10*th, and Lastly*,—The result of the foregoing series of positions, directly tends to the subversion of many of the most popular geological theories, with regard to the former history of our earth. These theories are chiefly remarkable for endeavouring to account, by the laws of nature, for all things except the actual *creation* of crude mineral matter, (as in the case of " a fused mass," gradually cooling, and subsequently submitted to the *exclusive* action of the existing laws of nature;) and of organized bodies, " called into being " from time to time, according as the state of the earth admitted, (as in the case of *fish*, when the cooling mass at length permitted " the surrounding *vapours*" to be condensed; and when the waters resulting from such condensation, were at length *cool enough to admit of fish being so created**.) From this constant reference to the laws of existing nature, in a case where these laws cannot easily be applied, have resulted inconsistencies, and conclusions from doubtful or false premises, which have occasioned *obscurity* as a natural result: and as all *extraneous aid*, especially from the Inspired writings, has been invariably deprecated, upon the principle that these writings, however infallible they may be in points connected with *morality*, could not be expected to afford a like infallible testimony on *physical* points, it seems as if man were bent on searching out *his own path* towards the origin of all things, and this by a clue of his own winding, which only leads him more deeply into the mighty and perplexing labyrinth. Thus, amongst other subjects, the idea of adopting the *literal* interpretation of Scripture, as to the extent and duration of the Deluge, has now been, as it were *officially*, abandoned, the whole subject having been passed over in silence, in the latest and most important of our geological writings, thus tacitly rejecting one of the most explicit descriptions of facts contained in the whole of Revelation. This rejection of the Mosaic account of the Flood, has arisen almost entirely from its being avowedly *beyond the powers of the laws of existing nature to produce the effects described.* Unless the facts that have now been detailed, however, are to be regarded as mere phantoms of the imagination, the inferences to which they naturally lead, seem distinctly to corroborate the Inspired account of that great and *preternatural* event.

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* *Bridgewater Treatise on Geology*, Vol. I., pp. 35, 55, and 581.

From the discovery of this first false position in the theories of geology, we are, in like manner, led to doubt other inferences, which contradict and set aside the Mosaic Narrative of the earliest events upon the earth. The proofs of *rapidity*, and of the *uninterrupted* deposition of sedimentary matter, so totally different from any existing action on which we can form our judgment, seem to remove the *mode* of these strata entirely beyond the sphere of man's distinct comprehension; and lead us to attribute them *to the action of second causes indeed, but under the special and direct guidance of* THE GREAT FIRST CAUSE, in the same manner as the Deluge, and the present beautiful order of things resulting from it, seem to have been brought about. When, to this, we add the singular fact, (so little dwelt upon by those who strongly advocate *the uninterrupted action of the laws of nature, during unbounded periods of time,*) that in the whole series of geological formations, *each group, marked by its own distinctive mineral characters,* OCCURS BUT ONCE, instead of that indistinct and oft-repeated intermixture of similar mineral sediments, which we feel confident must now be in slow progress in the bed of the present sea, we only feel more deeply persuaded that *we cannot justly theorize on the mode, or degree of rapidity, of the old formations, by any analogy with such deposits as we now see in progress around us.*

We thus find ourselves finally brought round to the very point from whence almost all have originally started; and we are led to perceive, that the more widely we deviate from the path which has graciously been pointed out to us, as the only means of reaching the origin of the preternatural phenomena of our globe, the more deeply we become immersed in obscurity and in doubt. We find that the combined efforts, even of the ablest men, have proved totally incompetent successfully to contend against the simple yet unbending Words of Eternal Truth. And, although it may not be permitted to us fully to unravel all those hidden mysteries of the Creator, with regard to His splendid and Provident *designs*, in preparing this earth for man's reception, yet we now have sufficient proof of the special intervention of His Almighty hand, in bringing about effects which man, in his blindness, has sometimes looked upon as merely *natural*, and therefore *unavoidable*, in the common course of things. We now *know* from the existing face of nature, that former dry lands have been destroyed by a Flood, as Scripture had already informed us: and instead of anticipating, as some have done, *the frequent recurrence* of such destructive judgments, as being within the scope of mere *natural effects*, from *natural causes*, we may confidently trust to that solemn covenant, which has been graciously made with post-diluvial man, that *God will "not* AGAIN *curse the ground any more for man's sake;" "neither smite any more every living thing;"* but that, on the contrary, *"while the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night,* SHALL NOT CEASE."

THE END.

Grant all this Writer
Contends for Action of
Water internal &
external in the surface
of Earth. I dont follow
the flood was Universal
producing changes, as
I show in my Sept 1872
Manuscript book No 3.

P. 468. Note. He argues as though
flood done these things.
Agassiz,
& others show Icebergs have
levelled hills & filled valleys
more likely to be done long before
Animal life & Man than afterward,
Christ dont allude to Universal
flood. nor Paul.

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57, — 10th from the bottom, ditto ditto.
104, — 9th, for *has* read *have*.
120, — 6th, for *emboucheurs* read *embouchures*.
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